

FM 6-50

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Ch 1

FM 6-50

THE FIELD ARTILLERY CANNON BATTERY

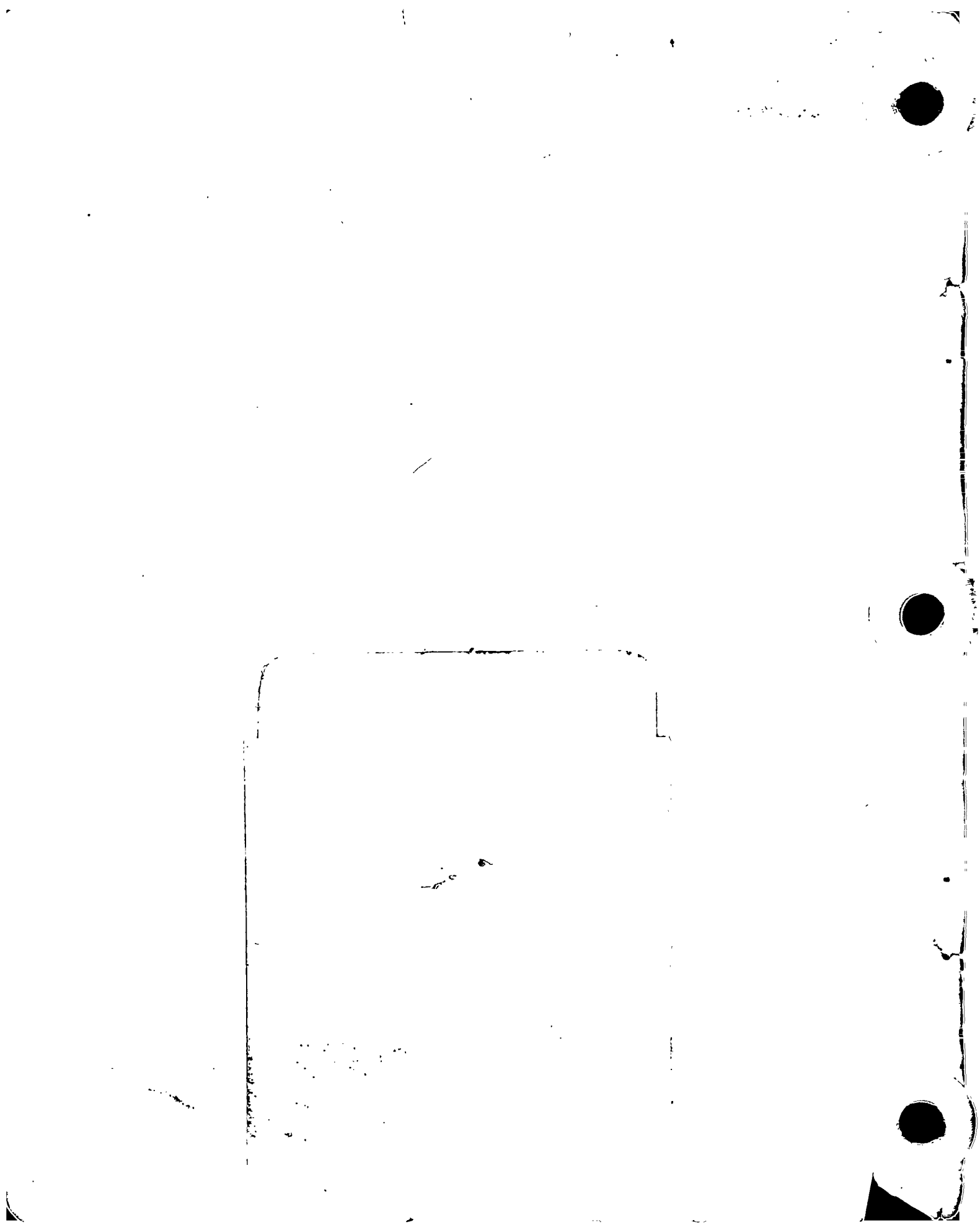
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DEPARTMENT OF THE ARMY
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THE FIELD ARTILLERY CANNON BATTERY

1. Effective upon receipt. This change updates FM 6-50, 30 June 1978. New or changed material is indicated by a star (*) preceding the material.

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*Change 1, FM 6-50 supersedes TC 6-20-9, 5 April 1978.

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This revised manual is designed to serve as the reference document for the cannon battery for both training and fighting. Its primary target audience is the cannon battery leader.

The purpose of this preface is to highlight the major areas of change in this "product improved" field manual. Additionally, pertinent ongoing and imminent TOE actions are discussed below.

Training

The most important aspect of the revision is the subject of *training*. To aid the battery leadership in making "train as we intend to fight" a reality, the following portions of the manual have been completely rewritten.

Chapter 16 discusses *development of the battery training program*, keying on the four-step training process of ANALYZE-PROVIDE-CONDUCT-EVALUATE. Throughout the chapter such training and evaluation tools as the ARTEP, Soldier's Manual (SM), Commander's Manual, Job Book, and Skill Qualification Test (SQT) are treated in terms of their utility in the programing and evaluation of training at all levels—individual, section, and unit.

Chapter 17 presents "*how-to-train*" techniques applicable to the cannon battery. It addresses training of the howitzer or gun sections, individual training in other MOSs, and progressive battery level techniques—ranging from the TEWT to a full-scale FTX.

Chapter 18 examines *maintenance procedures and training*, stressing preventive maintenance as a means to achieve readiness. The "tips" in the chapter itself are complemented by a new appendix I, containing a variety of tabulated maintenance aids.

Appendix C is a refined *cannon section evaluation* that may be used as a diagnostic tool, for crew training, or for section level competition.

Appendix D is an improved *gunner's qualification test*, designed to increase and maintain soldier proficiency on the weapon assigned. It is structured in terms of specific SM tasks.

Operations

- ★ Some changes have been made in part three of the manual, primarily to improve discussion of certain techniques. Chapter 7 has been rewritten to incorporate TC 6-20-9, *FA Cannon Battery Defense*.

Chapter 9 contains a more thorough treatment of *hasty survey* techniques, particularly directional traverse, simultaneous observation, observation of Polaris, and graphic resection.

Chapter 15 features a more complete discussion of *safety computations* (with examples), to include improved procedures for smoke, illuminating, and ICM computations.

Tactics

Although consideration of the enemy counterfire threat is not historically new, chapter 7 sets forth some detailed guidance on how to plan for *immediate actions* in response.

Equipment

- ★ The AN/PRC-68 radio, commonly called the *small unit transceiver (SUT)*, will be added to TOEs as indicated in chapter 13. This will not only provide a backup intrabattery communications system but will also greatly facilitate command and control (see app L).
- ★ In the near future, a *velocimeter* will be added to the TOE of each cannon battery. The velocimeter is a metering system that determines the actual muzzle velocity of a given projectile by means of the doppler principle. This system will permit calibration in the battery position (see app L).

★Organization

Implementation of the 3 x 8 concept in divisional direct support 155-mm battalions will begin soon. This organization will enhance fire support within the division and increase flexibility and capabilities within the firing battery. A training circular (TC) will be published to explain in detail this organization and its employment (see app L).

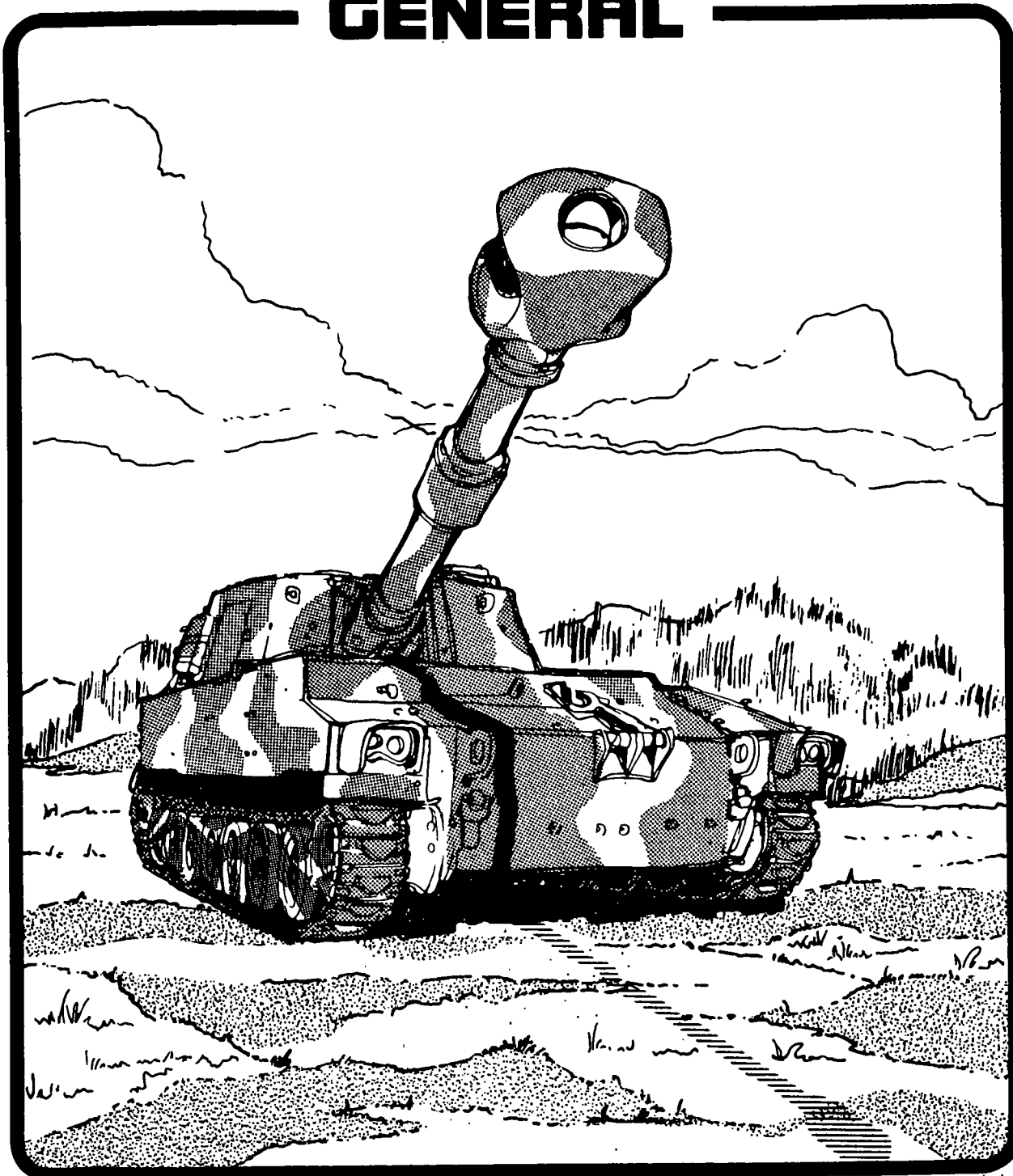
★Future Trends

Appendix L, Future Trends, has been incorporated. It briefly describes some of the ongoing materiel and doctrinal developments that will have an effect on cannon batteries.

The word "he" or "his" in this publication is intended to include both the masculine and feminine genders and any exception to this will be so noted.

PART ONE

GENERAL



CHAPTER 1. INTRODUCTION

CHAPTER 2. ORGANIZATION, MISSIONS, AND KEY PERSONNEL

Section I. Organization and Tactical Missions, Page 2-1

Section II. Duties of Key Personnel, Page 2-2

★CHAPTER 1

INTRODUCTION

"NOBODY SAID IT WAS GOING TO BE EASY."

—An Anonymous Battery Commander

1-1. Purpose

This manual has been prepared to serve as a how-to-do and how-to-train reference for the field artillery cannon battery in combat and in a training environment. It addresses techniques, considerations, and planning factors for combat operations—keyed to the US Army's mission of being prepared to fight anywhere on the globe, in any intensity of warfare, and in any battlefield environment. The emphasis is on a train-as-we-will-fight program to prepare for combat. This program is based on the real-world limitations of time and resources. Throughout the manual, the battery commander and his principal subordinates are shown how to manage their assets in the most effective manner to accomplish their unit's combat or training mission—and how to survive to fight or train another day.

1-2. Scope

a. FM 6-20-1, *Field Artillery Cannon Battalion*, covers operations of the field artillery cannon battalion, to include the headquarters and service batteries, and FM 6-20, *Fire Support in Combined Arms Operations*, covers the entire spectrum of fire support in combined arms operations. This manual deals specifically with the basic fire support unit—the cannon battery.

b. This manual sets forth the responsibilities and duties of key personnel for both training and fighting and recommends methods by which the battery commander can best manage his equipment and personnel assets.

c. It addresses doctrine and procedures for the cannon battery in offensive and defensive situations.

d. It provides guides for the training and testing of section personnel.

e. Throughout this manual, discussion using the term "howitzer" applies equally to a gun unless otherwise stated.

1-3. Target Audience

This manual is designed for use by:

a. Leaders of field artillery cannon batteries.

b. Leaders of field artillery headquarters and service batteries.

1-4. Changes and Corrections

Users are encouraged to submit recommended changes and/or comments to Commandant, US Army Field Artillery School, ATTN: ATSF-TD-TL, Fort Sill, Oklahoma 73503. Comments should be keyed to the specific page, paragraph, and line. Rationale should be provided in support of comments to insure complete understanding and evaluation.

1-5. References

FM 6-50 is designed for use in conjunction with user's manuals for the appropriate weapon systems and other applicable field and technical manuals. See appendix K for a list of references.



CHAPTER 2

ORGANIZATION, MISSIONS, AND KEY PERSONNEL

Section I. ORGANIZATION AND TACTICAL MISSIONS

2-1. General

★ The mission of the field artillery is to destroy, neutralize, or suppress the enemy by cannon, rocket, and missile fire and to assist in integrating fire support into combined arms operations. The field artillery cannon battery is the firing unit of the cannon battalion. It has the personnel and equipment necessary to move, shoot, and communicate. The cannon battery may operate as a separate tactical unit for limited periods of time. When the battery is operating independently, additional personnel and equipment may be attached to meet the requirements of the mission.

2-2. Organization

a. The organization of all cannon batteries is fundamentally the same (fig 2-1). Differences in organization stem from the caliber of the weapon, whether it is towed or self-propelled, and whether the battery is in a divisional or nondivisional battalion. The battery consists of the:

- (1) Battery headquarters.
- (2) Communications section.
- (3) Firing battery.

(a) Light and medium batteries (105-mm and 155-mm howitzer) have six cannon sections.

(b) Heavy batteries (8-inch howitzer and 175-mm gun) have four cannon sections.

- (4) Ammunition section.

b. The battery headquarters provides the personnel and equipment required to perform mess, supply, and maintenance functions for the battery. References covering these operations are in appendix J.

c. The communications section works with the battalion communications section to install and maintain communications for the battery.

d. The firing battery consists of the personnel and equipment required for determining firing data and firing the cannons. It includes the firing battery headquarters, the battery fire direction center (FDC), the battery operations center (BOC), and the cannon sections.

e. The ammunition section consists of the personnel and equipment necessary for battery ammunition resupply.

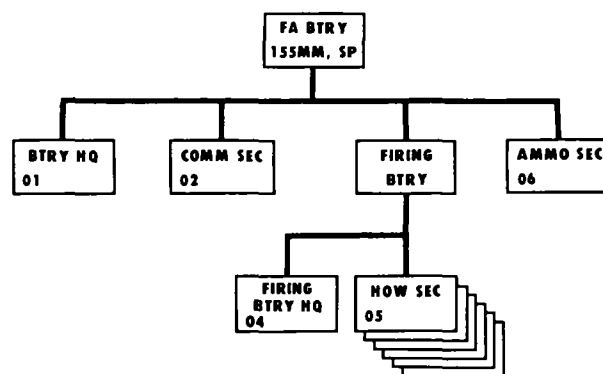


Figure 2-1. Typical cannon battery organization.

f. The field artillery battery of the regimental armored cavalry squadron (howitzer battery) is a modification of the typical battalion cannon battery. It is designed to function independently and to perform most of its own support functions. It is organized, trained, and equipped to operate in direct support of the armored cavalry squadron. A significant addition to the howitzer battery is the battery detail, which includes the communications section, a FADAC repairman, and a survey section. Also, the fire support teams (FIST) that support the squadron's maneuver elements are assigned to the battery.

★ g. The battery commander must realize that the ability of his unit to accomplish its mission is constrained by its very organization. He must plan and train for operating in an intense, 24-hours-a-day,

combat environment. If the battery is to function for sustained periods, sections must be organized into shifts to enable mission accomplishment and allow for *sleep*. The unit that fails to organize internally for sustained combat will exhaust itself and become ineffective. The belief of the past that it is unmanly to sleep must be dispelled. During lulls in action, individuals must be allowed to catnap. The commander cannot allow the tempo of combat to burn his unit out.

2-3. Tactical Missions

a. When a cannon battalion is assigned a tactical mission of DIRECT SUPPORT (DS) of a brigade-size force, cannon batteries provide the fires to support that force. FISTs from the cannon battalion are provided to the companies/company teams of the supported unit.

★ b. When a cannon battalion is assigned a tactical mission of REINFORCING, GENERAL SUPPORT REINFORCING, or GENERAL SUPPORT, its batteries contribute reinforcing fires to other FA or the battalion provides fires for the force as a whole as directed by the force artillery headquarters.

c. Additionally, the battery may function in a DEDICATED role. Dedicating the fires of a battery is an extension of the direct support mission. In a dedicated role, a battery provides fire support to a specifically designated maneuver company/team that is moving to contact. Fire planning considerations and techniques are discussed in FM 6-20.

Section II. DUTIES OF KEY PERSONNEL

2-4. Battery Commander

a. The battery commander (BC) is responsible for everything his command does or fails to do. Some specific responsibilities are listed below.

(1) Insuring that the battery accomplishes its mission.

(2) Training the battery for combat.

(3) Maintaining materiel and equipment.

(4) Maintaining high standards of discipline and morale.

(5) Preserving the health and physical fitness of the battery personnel.

(6) Insuring adherence to proper safety precautions.

(7) Performing reconnaissance, selection, and occupation of the battery position.

(8) Maintaining ammunition supply.

(9) Supervising the activities of the fire direction center (FDC), when necessary.

(10) Insuring the battery's survivability, to include proper concealment and adequate defense.

(11) Planning and controlling the unit marches and movements.

(12) Supervising the security, preparation, and delivery of special weapons, if applicable.

(13) Insuring that the battery functions in accordance with regulations and policies of higher commanders.

(14) Keeping the battalion commander and the personnel in his battery informed of the current situation.

(15) Establishing and maintaining a high degree of communications and electronics security.

(16) Managing the assignment of personnel within the battery.

b. In carrying out his command responsibilities, the battery commander:

(1) Plans his training program. He follows up on the progress of training by

personally supervising and participating in the training.

(2) Makes frequent inspections to insure that his orders are being carried out; that living quarters are adequate and well policed; that food is appetizing, properly prepared, and served on time; and that routine work is equitably distributed.

(3) Makes himself available for discussions with battery personnel on matters of a personal nature.

(4) Maintains discipline.

(5) Manages the assignment of personnel to insure the right man is placed in the right job.

(6) Insures the responsiveness of the personnel support system to the needs of the individual.

(7) Instructs and cross-trains key subordinates in their duties.

(8) Keeps his troops informed.

(9) Emphasizes the maintenance and proper use of all equipment.

(10) Insures application of the principles of supply economy.

(11) Assigns responsibilities and delegates authority to his officers and noncommissioned officers consistent with their positions.

c. The plans and orders of the battery commander are based on those received from the next higher command and his personal desires. These plans set forth a logical sequence for actions by each battery element in the accomplishment of the battery mission. The battery commander normally issues brief and informal oral orders. These orders fit specific situations and do not repeat standing operating procedures (SOP).

2-5. Executive Officer

a. The executive officer (XO) is the battery commander's principal assistant. During the BC's absence, the XO is the acting commander and assumes all the duties and responsibilities discussed in paragraph 2-4. When the BC is present, the XO ordinarily commands the firing battery portion of the

battery. In some tactical situations, the XO may also perform the duties of the fire direction officer (FDO).

b. The XO is specifically responsible for:

(1) Supervising the battery as it occupies the firing position, and insuring the track plan is followed.

(2) Verifying the lay of the battery upon occupation of a position.

(3) Measuring and reporting piece direction as required.

★ (4) Determining the executive officer's minimum quadrant elevation (XO's min QE).

(5) Insuring that boresighting is accomplished as soon as possible and as often as necessary.

(6) Insuring that timely and accurate fires are delivered by the cannon sections.

(7) Insuring that before-, during-, and after-operation maintenance is conducted.

(8) Insuring that position area improvement (camouflage, hardening, etc.) begins as soon as possible and progresses at an acceptable rate.

(9) Insuring that ammunition is properly protected from the elements and enemy fire.

★ (10) Rendering the XO's report to the fire direction center. (See paragraph 8-20 for a typical report.)

★ (a) Sometimes, because of multiple crests, it is necessary to determine more than one XO's min QE for the sector of fire. In this case, the XO reports each XO's min QE and its related deflection (e.g., DEFLECTION 2850 TO 3200, XO's MIN QE FUZES QUICK AND TIME, CHARGE 3 GREEN BAG, 100; DEFLECTION 3200 TO 3650, XO's MIN QE FUZES QUICK AND TIME, CHARGE 3 GREEN BAG, 104).

(b) When directed, the XO reports the amount, type, lot numbers, and weight of projectiles; powder temperatures; lateral limits of azimuth or deflection; maximum elevation when high-angle fire is to be used; and visible aiming points with referred deflections.

(11) Insuring that intrabattery communications are established as prescribed.

(12) Insuring that safe practices are observed, to include proper fire commands, safe firing data (not firing below minimum QE), and proper ammunition handling and storage.

(13) Insuring that each section chief knows the location of his supplementary position and that the route to this position has been reconnoitered.

(14) Coordinating with the first sergeant to determine sectors of fire for each howitzer to complement the overall battery defense plan.

(15) Supervising the development of range cards for howitzers and other crew-served weapons.

(16) Insuring that ammunition is distributed to the cannon sections according to anticipated needs determined by the FDC.

(17) Insuring in coordination with the FDC that a standby (hot) platoon has been designated for instant reaction to a fire mission.

(18) Training and supervising the activities of the firing battery.

2-6. Assistant Executive Officer

a. The assistant executive officer (AXO) performs duties as prescribed by the XO. He is normally charged with the responsibility of supervising the FDC. He must also be thoroughly familiar with the duties and responsibilities of the XO (para 2-5), since he may perform all or part of these duties in some situations. During 24-hour operations, the AXO and XO will normally divide the responsibility of supervising the FDC.

b. The functional job title of fire direction officer (FDO) is used to refer to the officer performing that duty. The FDO is specifically responsible for:

(1) Insuring the accurate and timely production of firing data.

(2) Assigning duties to personnel in a

manner that facilitates continuous operation, in shifts if necessary.

(3) Insuring that before-, during-, and after-operation maintenance checks are performed on the section vehicle, radios, computer, and generators.

(4) Insuring that locations of friendly units, boundaries, and fire support coordination measures are prominently posted and kept current.

(5) Insuring the proper use and functioning of battery wire and radio nets.

(6) When necessary, deciding how to attack a target and issuing the fire order.

(7) Insuring that FDC records are complete and accurate.

(8) Insuring that data for prearranged fires are properly disseminated and understood by FDC and cannon section personnel.

(9) Inspecting the map and, if necessary, computing the minimum QE to intermediate crests not visible from the battery area.

(10) Insuring that the camouflage and position-hardening effort in the FDC area begins as soon as possible and progresses at a satisfactory rate.

(11) Insuring that accurate and complete fire commands are sent to the cannon sections.

(12) Insuring that the quadrant announced in each fire mission is not below the minimum quadrant elevation for visible or intermediate crests.

(13) Coordinating with the battalion S3 to determine the type and amount of ammunition to be requisitioned.

(14) Coordinating with the XO to insure that a hot platoon has been designated.

(15) Preparing the safety diagram and verifying the plotting of safety limits on the firing chart.

(16) Providing safety data to the cannon chiefs of section, and updating it as necessary.

(17) Insuring that the data in fire commands are within the specified safety limits, and that rounds are not fired until the prescribed coordination has been accomplished.

2-7. First Sergeant

a. The first sergeant is the senior noncommissioned officer in the battery and the BC's primary enlisted supervisor. In peacetime, the specific duties and responsibilities of the first sergeant are dictated by the local SOP and vary from unit to unit.

b. In combat, the first sergeant's primary responsibilities are:

(1) Supervising the activities of personnel assigned to the battery headquarters.

(2) Establishing the battery operations center (BOC).

(3) Developing the overall defensive plan.

(4) Coordinating directly with all enlisted supervisors and keeping them informed.

2-8. Chief of Firing Battery

a. The chief of firing battery (CFB) is the XO's principal enlisted assistant. Normally, he is charged with the specific responsibility of direct supervision of the cannon section chiefs during training and combat operations.

b. The chief of firing battery must be prepared to perform all the duties of the XO.

2-9. Gunnery Sergeant

a. The gunnery sergeant (GSG) assists the chief of firing battery in executing his duties and must be prepared to perform all the duties of the XO.

b. His primary responsibilities are:

(1) Performing the duties of the CFB during split battery operations.

(2) Working in shifts with the CFB during 24-hour operations.

(3) Assisting the BC in the reconnaissance of battery positions by:

(a) Setting up the aiming circle and orienting it for direction.

(b) Reading initial deflections to the gun guides.

(c) Supervising the activities of the gun guides.

(d) Performing other duties in the new position that the BC may assign.

(4) Laying the battery as it occupies the new position.

2-10. Chief of Section

a. In general, the chief of section is responsible for insuring that his section is trained; that all of his equipment is properly maintained; that correct, safe data are set on his weapon; that ammunition is properly stored, handled, and prepared; and that proper safety precautions are observed at all times.

b. The section chief's primary responsibilities are:

(1) Conducting section training, both individual and collective.

(2) Insuring that the weapon is properly emplaced, laid, and prepared for action.

(3) Establishing section priorities for preparing the weapon and the firing position. Unless it conflicts with specific instructions from the XO or CFB, the memory aid TLASBAPP should be used as a guide for the accomplishment of the following tasks. The section should be organized so that as many of these tasks as possible are accomplished simultaneously.

T: Trail, spade, or firing platform emplacement.

L: Lay the weapon.

A: Aiming points.

S: Site to crest.

B: Boresight.

A: Azimuth markers.

P: Prefire checks.

P: Position area improvement (camouflage, hardening, etc.).

(4) Measuring and reporting site to crest.

(5) Determining piece-to-crest range.

(6) Supervising the entire section during firing.

(7) Observing and checking the functioning of materiel during firing and immediately reporting errors, unusual incidents, or equipment malfunctions to the XO or FDC.

(8) Segregating ammunition by type and lot.

(9) Insuring that before-, during-, and after-operation maintenance is performed in accordance with the applicable manual.

(10) Insuring that equipment is stowed habitually according to the unit's loading plans and as prescribed in the appropriate manual.

(11) Preparing range cards for the howitzer and the section's other crew-served weapon(s).

(12) Supervising the appropriate logbook entries and making equivalent full charge (EFC) computations in accordance

with the appropriate manual.

(13) Controlling the firing of the howitzer during direct fire operations.

(14) Redistributing the duties of personnel to facilitate mission accomplishment when the section is operating with a reduced crew.

(15) Organizing the section into shifts to facilitate 24-hour operations.

(16) Implementing the assigned portion of the battery defense plan.

(17) Insuring that the records below are completed correctly and that data are kept current.

(a) Appropriate equipment logbook forms are discussed in TM 38-750.

(b) The DA Form 4513 (Record of Missions Fired, fig 2-2) is used by the section to record data designated as standard, fire commands, and a running total, by type and lot, of ammunition on hand.

(c) Each section should have certain information recorded on a reference card. The card shown in figure 2-3 is a sample format, and contains the minimum information necessary.

c. The chief of section must be prepared to assume the duties of CFB/GSG if necessary.

RECORD OF MISSIONS FIRED		SECTION #3		DATE TODAY		PAGE / OF		AMMUNITION/FUZES ON HAND													
STND DATA: ADJ PIECE: #3 ① SH: HE LOT: XY FZ: Q								HE	HE	WP	CM	LL	GB	WB	Q	TI	VT	TI			
								X	T	S	H	K	Z	Y	5 ₇	5 ₄	7 ₂	5 ₇			
								56	42	7	63	10	81	97	69	40	39	65			
PIECES FOLLOW PIECES FIRE MOF	SP INSTR	SH	LOT	CHG	FZ	TI	DF	QE	METHOD FFE	AMMUNITION EXPENDED											
BA				5			3240	341	② VT I/E	①						①	①				
							3220	350		②						②	②				
B②					VT	23.0	3225	355		④						④	67		②		
	EOM									52						93			37		
BA			TY	4			2954	325	③ I/E		①					①	①				
							2979	311			②					②	②				
B③							2967	317			⑤					⑤	⑤				
	EOM									37						88	62				
B②		ICM	HY	6	TI	21.2	3158	269					②			②				②	
	EOM												61			86				63	

DA FORM 4513
1 MAY 76

REPLACES DA FORM 4199, 1 JAN 74, WHICH IS OBSOLETE.

Figure 2-2. DA Form 4513, Record of Missions Fired.

FM 6-50



GUNNER'S REFERENCE CARD

AZ OF LAY

DF TO AC
DIST TO AC
DF TO COLL
DF TO SAFETY CIR
DF TO AP
DF TO DAP
RIGHT LIMITS
MAX QE
LEFT LIMITS
MIN QE
STANDARDS
ADJ PIECE
SHELL
LOT
FZ

PRIORITY TARGETS

PRIORITY	TGT DESIG	SP INSTR	RDS	SH	LOT	CHG	FZ	TI	DF	QE

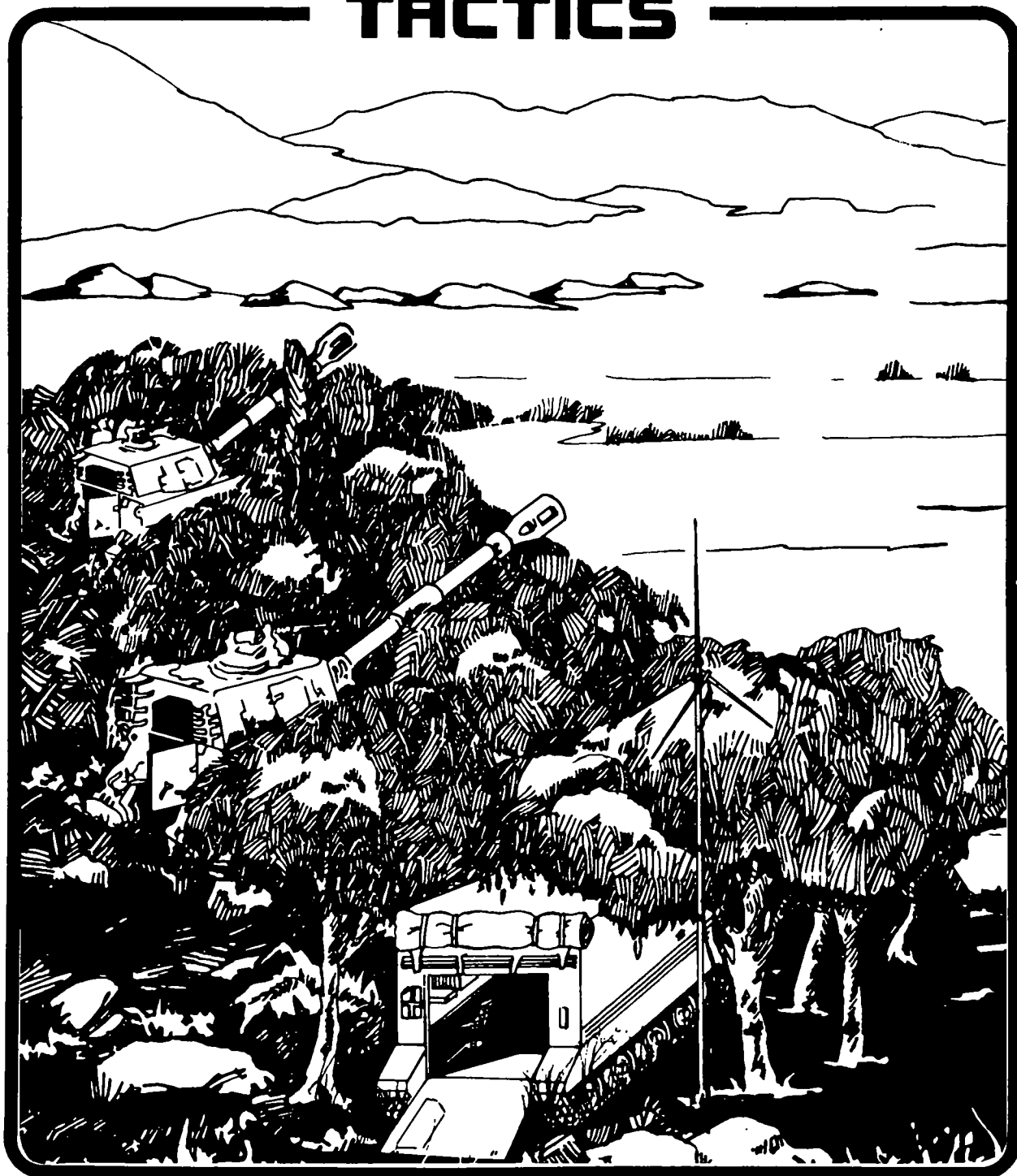
POSITION CORRECTIONS

SECTOR	DF CORR	QE CORR	FS CORR
PRIMARY			
RIGHT			
LEFT			
CONVERGED			

Figure 2-3. Gunner's reference card.

PART TWO

TACTICS



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CHAPTER 3

RECONNAISSANCE AND THE ADVANCE PARTY

Section I. THE RSOP

3-1. General

On the battlefield, a sophisticated enemy is capable of locating and engaging a battery in a variety of ways. To survive we may be required to move frequently. Frequent movement, however, reduces responsiveness and necessitates greater reliance on other batteries to assume the mission during displacement. To minimize movement time, all key personnel must be capable of performing the reconnaissance, selection, organization, march, and occupation tasks *quickly and efficiently*. The keys to successful reconnaissance, selection, and occupation of position (RSOP) are discipline and team effort, which come from frequent and effective training.

3-2. Considerations

The headquarters controlling the movement of the battery directs the essential elements of the movement—*when, where, and how*. These elements of movement may be specifically spelled out in an SOP or operation order, or may simply be specified in an oral mission statement or "frag" order.

Depending upon the tactical situation, the control headquarters may delegate to the battery the responsibility for any one or all of the essential elements of movement. The battery commander must anticipate movement. He must plan in advance for displacement to new, alternate, or supplementary positions and announce movement techniques to be used. The battery

commander should advise the controlling headquarters of any factors to be considered in determining the *who, when, where, and how* of the movement.

It is desirable that all key personnel of the battery understand the considerations involved in movement. *When* to move and *where* to move are covered in this chapter.

How to move is covered in chapter 5. The unit must be prepared to move:

a. *To support the maneuver force.* A movement is indicated when the battery cannot cover a significant portion of the area of influence of the supported maneuver force.

b. *During lulls in action.* If the battery needs to move because of a change in the FEBA, it may be best to move during a lull in combat action. A lull may not last long, so caution must be exercised.

c. *When the position becomes untenable.* The battery should move whenever it cannot deliver effective fire because of enemy attack or when natural disturbances (e.g., fires and floods) cause the position to be untenable. Depending upon the tactical situation, the battery may displace to one of its previously selected alternate positions. Again, anticipation is the key to minimum disruption. A rally point should be established so that if an emergency displacement is required, stragglers will have a known place to go on their own, where a guide from the battery will be positioned to help them rejoin the unit. For further discussion of the tactical considerations in displacement and positioning, see chapter 7.

Section II. RECONNAISSANCE

3-3. Definition

Reconnaissance is the examination of terrain

to determine its suitability for accomplishment of the battery mission.

3-4. Receipt of Order

The battery commander may receive displacement orders ranging from a five paragraph operation order to a simple authenticated radio message from higher headquarters. He is given, or selects himself, the general location of his new position, the azimuth of fire, the time to depart and/or be in the new position, and the routes to be used.

3-5. Methods of Reconnaissance

a. Before the BC can plan adequately for displacement, he should know the three methods of reconnaissance.

(1) *Map reconnaissance.* All anticipated moves should begin with a map reconnaissance of the proposed position area and the routes to be traveled. Map reconnaissance is not totally reliable, as terrain features may have changed since the map was printed and true surface conditions cannot be determined. However, a map reconnaissance of tentative routes and proposed position areas should be made before a ground reconnaissance is conducted. Aerial photographs are usually more current and provide more detail of the area than maps.

(2) *Air reconnaissance.* If the assets are available and the situation permits, an air reconnaissance should be made. The information gained from an air reconnaissance may be instrumental in the selection of the specific route(s) to be used and areas to be occupied. Air reconnaissance is a fast method, but true surface conditions may not be distinguishable or may appear distorted. The pilot must be careful that his flight plan does not compromise the route or the new position area.

(3) *Ground reconnaissance.* A ground reconnaissance is the best method of determining the suitability of routes to be traveled and positions to be occupied. The actual condition of the route(s) to, and the terrain pattern within, the proposed area are

seen as they exist. This method, however, is more time consuming than either the map or air reconnaissance.

b. Each method of reconnaissance offers the BC a different but complementary perspective of the best route to the best position. If the situation permits and time is available, all three methods may be used. In most instances, the BC performs a map reconnaissance, selects a tentative route, and then conducts a ground reconnaissance.

c. Vital information revealed en route that may affect the displacing unit adversely must be transmitted to the unit prior to its movement.

3-6. Planning the Reconnaissance

a. The governing factor in planning the reconnaissance is accomplishment of the mission. In a fast-moving tactical situation, the time available for *planning* the reconnaissance, *assembling* the party, and *conducting* the RSOP may be only minutes, excluding travel time.

b. The primary and alternate routes and distances to the new position area must be considered. A determination of how many route guides or markers will be needed should be made prior to departure.

c. The organization of the advance party should be tailored for the performance of specific duties. The BC takes to the new position ONLY the route guides and the personnel and equipment necessary for preparation of the position for occupation. These personnel also provide their own defense and initial defense of the new position area.

d. A standard nucleus of advance party personnel should be established by SOP. The equipment required to prepare a new position should be preloaded or identified and maintained in such a manner that it can be located and loaded on the prescribed vehicle without delay.

Section III. THE ADVANCE PARTY

3-7. General

The method by which the battery displaces and occupies a new position, day or night, is greatly influenced by whether or not a reconnaissance can be made and by the time available.

3-8. Assembling the Party

For either a deliberate or a hasty occupation, a prearranged signal or procedure should be used to alert and assemble the advance party. The signal should be specified in the unit SOP, which should also list the personnel, equipment, vehicles, and place of assembly.

3-9. Organization of the Advance Party

a. Two vehicles are usually required to carry the advance party and its equipment. A suggested organization for a two-vehicle party is shown in table 3-1.

b. If the situation is such that the BC can provide only one vehicle for his advance party, basically the same personnel and equipment listed in table 3-1 can be carried in the M561 Gama Goat. If the BC has to reduce the organization, he can eliminate the optional communications chief or specify one gun guide per two howitzers.

★ Table 3-1. Suggested Advance Party

PERSONNEL	EQUIPMENT
Battery commander and driver	1 1/4-ton or 1/4-ton vehicle with radio, map, compass, binoculars, and mine detection kit
First sergeant	Map, grid sheet, overlay paper, coordinate scale, protractor (for construction of defense diagram), and NBC kit
One battery operations center (BOC) representative	FDC equipment in BOC
Gunnery sergeant, assistant executive officer, or chief of firing battery	BOC vehicle with fire direction equipment, RC-292 antenna, declinated aiming circle with tripod and night lighting device, one TA-312, and communications wire, and one light machinegun
Gun guides (one per howitzer)	Pantel marking and guide stakes, compass, communication wire (to reach from weapon to SB-16, when available), one telephone TA-312 (when available), one set of aiming posts with night lighting devices, one axe, and one shovel
Communications representative	One SB-16, one TA-312, and communications wire
Required route guides	
Note: When preparing for night operations, all personnel should have flashlights with filters.	

3-10. Taking a Firing Capability Forward

Depending on the mission and tactical situation, the BC may take an M548 ammunition carrier, a howitzer section, or a platoon forward with the advance party. Reasons for taking howitzers forward may be:

- a. To register from the new position or perform an offset registration from a position outside the new battery position area.
- b. To provide fire support to forces not supportable from the old position.
- c. To confuse moving - target - locating radars, as part of the infiltration plan.

3-11. Executing the Reconnaissance

- ★ a. Prior to departing for a new position area, the BC must give key information to his XO and advance party to provide continuity if he becomes a casualty. As a minimum, this briefing should include information contained in the five-paragraph field order, as depicted:

1. SITUATION

a. *Enemy situation.* Enemy strength and capabilities.

b. *Friendly situation.* Tactical situation, location of adjacent units, and reinforcing artillery.

2. MISSION

Brief statement of mission of supported maneuver unit and of the artillery battalion.

3. EXECUTION

a. *Concept of operation.* Location of area battery will occupy, azimuth of fire, and routes battery will use to move into position.

b. *Firing battery.* Coordinates of the physical location of battery center, azimuth of fire, method of lay, type of firing chart, primary and alternate routes to be used by the firing battery, and order of march of the cannon sections.

c. *Support elements.* Location of ammunition dump, vehicle dispersal area, mess area, field storage location (FSL), and route to be used by support elements.

d. *Perimeter defense.* Enemy avenues of approach and guidance to first sergeant on placement of outposts and crew-served weapons.

e. *Coordinating instructions.* Location at which guides are to meet first sergeant, instructions for guide to lead battery from release point to battery position area, and time the battery will arrive.

4. ADMINISTRATION AND LOGISTICS

Messing arrangements and location of aidmen.

5. COMMAND AND SIGNAL

a. *Signal.* Priority of wire circuits, location of battery switchboard, and location of wire terminals at battalion.

b. *Command.* Location of battery command post and location of battalion command post.

b. After making a map reconnaissance, completing his planning, and briefing necessary personnel, the BC is ready to proceed to the new location. While moving, he verifies the suitability of the primary route. He also checks—

- (1) Cover and concealment.
- (2) Location of obstacles.
- (3) Likely ambush sites (plans on-call suppressive fires as required).
- (4) Time required.
- (5) Distance.
- (6) Likely position areas along the route.

c. If time allows the BC or another member of the party to return to the old position, he should check the alternate route.

★ *d.* Upon arrival at the new position area, the advance party rapidly dismounts and establishes a close-in, tight perimeter around the battery commander. The battery commander then directs the first sergeant to establish outposts for local security and to have the remaining advance party personnel sweep the position area. This sweep is made to insure that the position is free of enemy troops; booby traps; mines; and nuclear, biological, and chemical (NBC) hazards. The sweep must cover the proposed position and also the surrounding terrain from which the enemy could attack. Care must be taken at all

times to keep the advance party and its vehicles concealed.

★ *e.* During the sweep, the battery commander materializes the azimuth of fire on the ground, tentatively organizes the position, and formulates his plan of occupation. After the sweep, advance party personnel begin preparation of the position for occupation by the main body. As their tasks are completed, the first sergeant uses these personnel to establish a skeletal perimeter to augment the outposts.

★ Section IV. TRAINING

3-12. Major Tasks

Members of the advance party must be trained, both individually and collectively. Table 3-2 lists some of the major tasks to be accomplished by advance party personnel.

3-13. Training Program

A sound training program for an advance party can be conducted in three phases.

a. Phase I. During phase I, all personnel who might logically be expected to be members of the advance party are trained in the individual skills indicated in table 3-2. This training can be integrated into normal section training and should be highlighted whenever possible during other training.

b. Phase II. In phase II the battery commander conducts a tactical exercise without troops (TEWT) with key personnel of the advance party. Examples of how to use this technique are discussed in chapter 17.

This phase need not follow phase I, but the two phases might well be conducted simultaneously.

c. Phase III. Phase III is a rehearsal of the advance party in a simulated or an actual tactical environment. All the collective skills indicated in table 3-2 can be measured, critiqued, and reinforced during a rehearsal. The commander must make rehearsals as realistic as possible. Advance party members should be rotated frequently in order to cross-train as many people as possible. The standards in the appropriate ARTEP should be used as a guide for the conduct of this training.

During combat a unit maintains proficiency in those skills that are used day to day. If not used or practiced, skills that may be required later can be lost. Consideration should be given to conducting training during combat lulls. Such training will insure that a battery maintains its ability to perform all skills required.

Table 3-2. Advance Party Major Tasks

MAJOR TASKS							★				
	BC	XO	AXO	1SG	CFB	GSG	HOW SEC CHIEF	COMM REP	BOC/ FDC	BC's DRIVER	HOW SEC PERSONNEL
1. Select a tactically sound battery position. (C)	X	X	X	X	X	X					
2. Select alternate and/or supplementary positions. (C)	X	X	X	X	X	X	X				
3. Select proper howitzer locations. (I, C)	X	X	X	X	X	X	X				X
4. Conduct a security sweep of new position area. (I, C)	X	X	X	X	X	X	X	X	X	X	X
5. Select locations for service vehicles (mess, maint, ammo). (C)	X	X	X	X	X	X					
6. Select a proper site for the BOC and FDC. (I, C)	X	X	X	X	X	X		X	X		
★ 7. Establish internal wire communications by setting up and hooking up wire to the SB-16 (when available) or running a hot loop. (I, C)				X	X	X	X	X	X		X
8. Set up, level and orient the aiming circle on the azimuth of fire. (I, C)	X	X	X	X	X	X	X				
9. Aline howitzer guide stakes on an azimuth with the compass. (I,C)					X	X	X				X
10. Orient the aiming circle over the pantel marking stake and direct the emplacement of aiming posts. (I, C)	X	X	X	X	X	X	X				
11. Measure an initial site to crest using the aiming circle or an M2 compass.	X	X	X	X	X	X	X				

Table 3-2. Advance Party Major Tasks—continued

12. Select a route and guide a vehicle into position, adhering to the unit's track plan. (C)				X	X	X	X	X	X	X	X
13. Prepare a firing chart for use. (I)	X	X	X						X	X	
14. Compute firing data using a GFT fan (I)	X	X	X						X	X	
15. Assemble and erect the RC-292 antenna correctly for a designated frequency. (I)								X	X	X	
16. Monitor NBC equipment and mine detector. (I)				X		X		X		X	
17. Lay the battery during an emergency occupation to answer an emergency call for fire. (I, C)		X	X		X	X	X				
18. Develop a sound track plan. (C)	X	X	X	X	X	X					
19. Determine distances needed for terrain gun position corrections. (I, C)			X		X	X	X				X
20. Conduct a map recon. Select primary and alternate routes and checkpoints and determine the order of march for the howitzers. (I, C)	X	X	X	X	X	X					
21. Use the M17 plotting board to determine piece displacement for terrain gun position corrections. (I)	X	X	X						X	X	

Note: I = Individual training C = Collective training



CHAPTER 4

SELECTION AND ORGANIZATION OF THE POSITION AREA

Section I. SELECTING THE POSITION

4-1. General

Having completed the route reconnaissance and arrived in the general area of the new battery position, the BC and his advance party conduct a sweep for enemy forces and prepare the position for occupation. Each member of the party must accomplish his job quickly and efficiently in order to insure maximum preparation for the arrival of the main body. The speed and smoothness of the actual battery occupation depend largely on the work of the advance party.

4-2. Considerations

The following are position selection considerations:

a. Mission. This is the most important consideration. The position should provide for fire throughout as much of the zone of influence of the supported maneuver force as possible.

b. Tactical situation. The tactical situation will largely dictate the location of the position area, the technique of positioning the howitzers and the use of terrain in defense of the battery.

★ *c. Communications.* The position must facilitate communications with stations within assigned and monitored radio nets.

d. Defilade. Defilade is protection from enemy observation and direct fire weapons by use of a terrain mask. The battery should not be positioned so close to the mask that the unit low-angle fire capabilities are restricted.

e. Defensibility. The position should facilitate both active and passive defense so that it—

(1) Can be entered without enemy observation.

(2) Offers effective cover and concealment, with emphasis on concealment.

(3) Avoids high-speed approaches from the FEBA.

(4) Has more than one entrance and exit route, preferably in the rear of the position.

(5) Takes advantage of existing terrain features.

f. Trafficability. The soil must be firm enough to support the vehicles of the battery, especially the loaded ammunition vehicles.

g. Weather. Weather conditions and the effect of weather on the terrain must be considered.

4-3. Types of Positions

The BC must select three types of positions.

a. Primary position. The primary position is the position from which a battery intends to accomplish its assigned mission.

b. Alternate position. The alternate position is one to which the entire battery moves in the event its primary position becomes untenable or the battery has to move for other reasons. Since the battery will continue its mission from the alternate position, it must meet the same requirements as the primary position and should be far enough away that the battery can escape the effects of enemy indirect fire on the primary position. *It should be reconnoitered and prepared for occupation as time permits.* Each section chief must know the route to the alternate position, because movement to that position may be by section.

★ *c. Supplementary position.* A supplementary position is selected for accomplishment of a specific mission, such as to conduct an offset registration, achieve extended range for a nuclear fire mission, adjust with a roving gun, or defend the primary position.

(1) Supplementary positions for defense of the battery should be platoon sized, and

selected to cover likely enemy avenues of approach. Routes to these positions must be reconnoitered by all gun guides and section chiefs.

(2) Positions for *offset registrations* and

roving guns should be far enough from the primary position so that counterfire will not affect the primary position. The BOC will likely accompany the offset registering piece or roving gun. For more details, see FM 6-40.

Section II. ORGANIZING THE POSITION

4-4. Formations

a. Because of the ability of the enemy to detect the unit and react quickly, the commander must place more emphasis on concealment and survival than on positioning for best sheaf effects in the target area. A compact position is vulnerable to air attack and to counterfire. A straight-line formation presents an easy target for strafing or low-level bombing attacks. Both of these formations should be avoided.

★ b. Conforming to terrain patterns helps to conceal the position and provides better possibilities for firing to the flanks and rear. Terrain gun positioning should be the primary method of occupying a position area whenever possible. Terrain gun positioning is the use of terrain to provide the maximum concealment and protection from the enemy. It means fitting the howitzers to the rolls, folds, and vegetation of the occupied land mass. However, the battery commander must consider the effects that terrain gun positioning and dispersion will have on the ability of the battery to defend the position. When the need for a 6400-mil firing capability is overriding and dictates the use of a small, tight, easily defended area, formations such as the star formation (fig 4-1) can be used.



Figure 4-1. Star formation.

★ c. Enemy attack capabilities may be so great and concealment so poor that either the battery must be spread over an abnormally large area or the howitzers must be grouped in small but scattered areas. Care must be exercised to insure that the area is not so large that the FDC cannot compute terrain gun position corrections (TGPC).

★ d. TGPC will provide acceptable effects on the target within the transfer limits if the battery position is within a box 400 meters wide and 200 meters deep. This box is centered over the battery center and oriented perpendicular to the azimuth of lay (fig 4-2). If the battery is more spread out than this, there will be less effect on the target within the stated transfer limits.

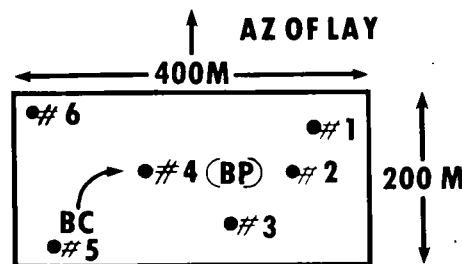


Figure 4-2. Battery position.

★ e. Regardless of the type of formation, the howitzers are numbered from right to left and front to rear as they face the azimuth of lay (fig 4-3). The howitzer numbers are assigned in each position and do *not* change as the azimuth changes.

★ f. The howitzers are also divided into platoons. Each platoon has two howitzers, and the platoons are referred to as *RIGHT*, *CENTER*, and *LEFT* (fig 4-4).

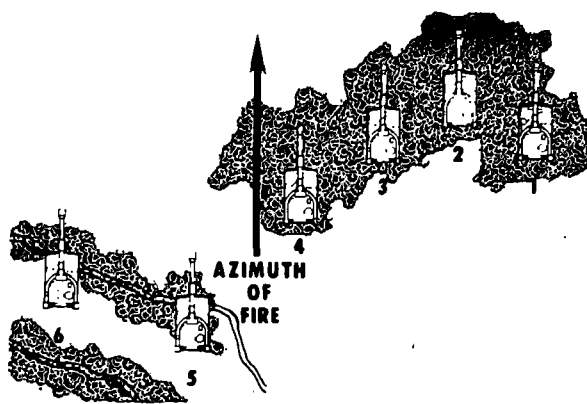


Figure 4-3. Howitzer numbering.

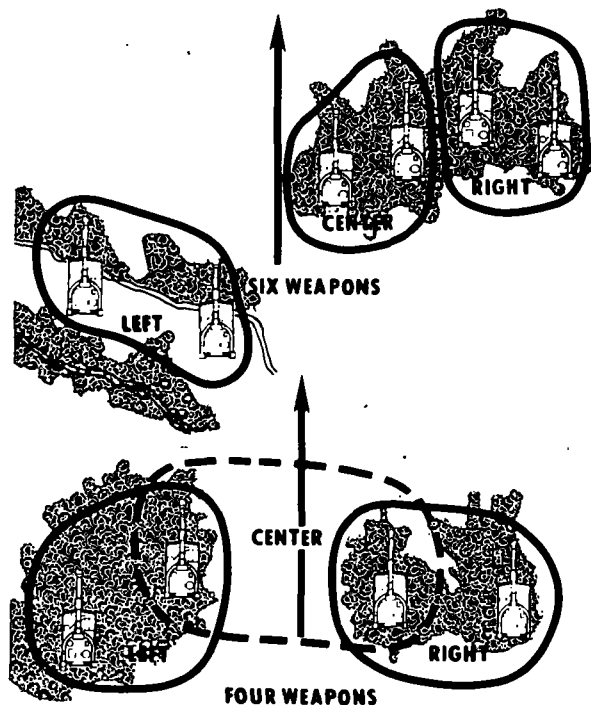


Figure 4-4. Platoon designations.

4-5. Battery Installations

a. Once the BC has selected the primary position, the advance party conducts a sweep and the BC tentatively selects positions for the howitzers and other battery installations.

(1) *Cannon sections.* An ideal position is one that provides defilade without unduly restricting the minimum elevation or sector of fire. Direct fire capabilities from the position should also be considered. The howitzers should be arranged to provide the best effects in the target area while taking advantage of natural cover and concealment.

★ (2) *Ammunition section.* The ammunition section area should be concealed, protected, and located 100 meters away from all battery installations. It should allow easy access to supply routes. Normally, ammunition is left on the vehicles to allow rapid displacement of the unit. If it must be off-loaded, it should be placed in an area that has good drainage. (Details on storage, care, and handling of ammunition are in chapter 14.)

★ (3) *Fire direction center.* The battery FDC should be located on a flank to minimize the effects of counterfire. The FDC must be able to communicate with the FISTs and battalion FDC. FM communications require electronic line of sight, so dead spots should be avoided if possible in selecting a firing position. Normally, a good map reconnaissance will reveal the positions where these dead spots are likely to occur because of line of sight. Additionally, the tentative location of the RC-292 antenna, if required, should be decided.

★ (4) *Battery operations center.* The battery operations center serves as the battery command post and as a limited-capability alternate fire direction center. It should be positioned as far as tactically feasible from the primary FDC to reduce the possibility that hostile action will damage both. The radios in the BOC should be remoted and the RC-292 antenna should be erected, when required, to enable communications with distant stations.

★ (5) *Field storage location (FSL).* For units with a nuclear capability and with nuclear weapons present, an FSL must be established. It should be located in the most defensible part of the battery position area consistent with the availability of natural concealment and access routes. Requirements for establishing the FSL are in FM 100-50, *Operations for Nuclear-Capable Units*.

(6) *Service area.* When support vehicles accompany the firing battery, a service area will be established. The service area contains the vehicle dispersal, maintenance, and battery mess areas. Since these installations are not directly related to the delivery of fire,

they are located as far from the cannons as possible. The service area should be to the flank or rear of the cannons in an area that is accessible, that has firm ground, good drainage, cover, and concealment, and that provides adequate room for the dispersion of the vehicles. If terrain permits, vehicles

should be separated by a minimum distance of 50 meters. All vehicles not required at the various battery installations should be parked in the vehicle dispersal area.

b. Figure 4-5 shows a typical battery position area.

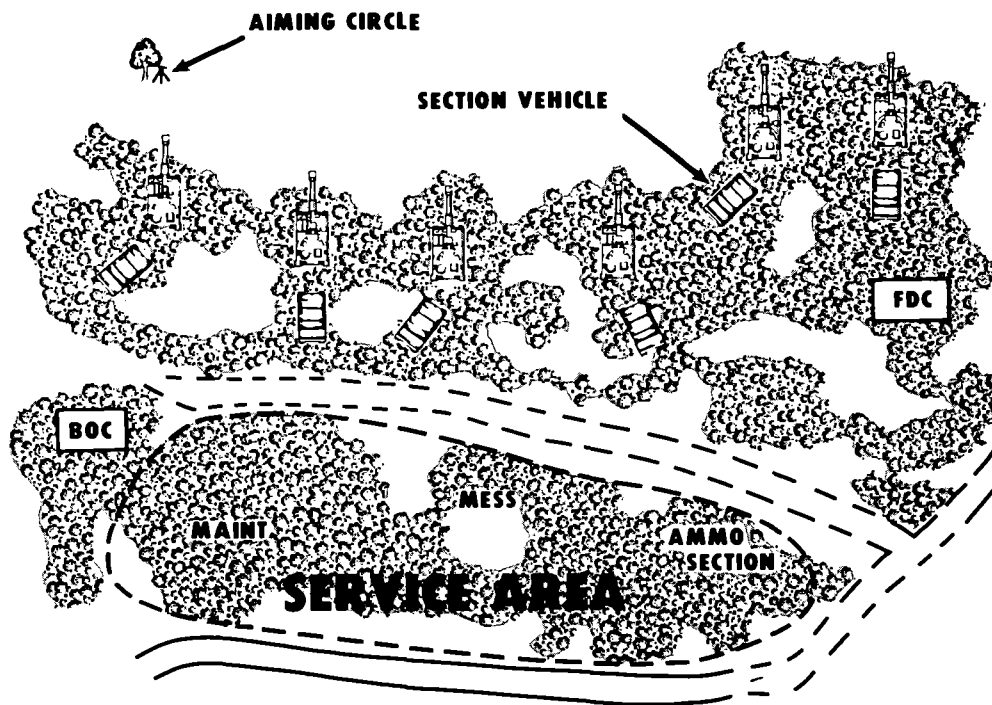


Figure 4-5. Type cannon battery position area.

Section III. PREPARATION FOR OCCUPATION

4-6. Preparation for Daylight Occupation

a. The BC finalizes his plan of occupation, giving priority to performing those tasks that facilitate immediate fire support to the supported maneuver force. The plan is not limited to, but should include, the following:

(1) The location of the base piece and other howitzers.

(2) The azimuth of fire, which the BC indicates by pointing out a terrain feature located on the azimuth or by pointing his vehicle in the direction of fire if a terrain feature is not available.

(3) Entrance and exit points. The BC indicates these points and provides guidance to the ISG for development of the battery track plan.

(4) The location of battery installations such as the aiming circle, FDC, BOC, ★ maintenance area, ammunition section, FSL, and mess area.

(5) Guidance on the scheme of defense.

(6) Location of the pickup point where the ground guides assemble to meet the battery. (Guides should not bunch up.)

b. As soon as the plan of occupation has been given, the key personnel begin

performing their duties. Specific responsibilities are:

(1) The BC establishes the specific position of each howitzer.

(2) The gunnery sergeant sets up and orients the aiming circle—

(a) Away from magnetic attractions when laying by grid azimuth.

(b) Where it will have line of sight with the panoramic telescopes.

(c) Where it can be concealed.

★ As soon as the panoramic telescope (pantel) marking stakes (fig 4-6) are emplaced, the gunnery sergeant measures and records the initial deflection to each pantel marking stake. If wire communications are established, he announces the initial deflection for each pantel marking stake to the appropriate gun guide over the wire line. If wire is not in, the gunnery sergeant hand-carries the initial deflection to each gun guide in order to maintain noise discipline and avoid the confusion of voice commands. The gun guide records his initial deflection and gives it to his gunner and section chief when the battery arrives.

The GSG gives this deflection, along with the distance from each weapon to the aiming circle, to the BOC member for application to the M17 plotting board. If the BOC representative is unable to plot the piece displacement on the M17 plotting board before arrival of the FDC, the GSG gives the deflection and the distance from the aiming

circle to each weapon to the FDO. The FDO uses these data in determining terrain gun position corrections.

(3) Each gun guide—

★ (a) Lays wire from his cannon position to the SB-16 or ties into the hot loop, if used. Additionally, he hooks up his TA-312 telephone (if available) to the internal wire system.

★ (b) Emplaces the pantel marking stake in the location designated by the BC. This stake marks the location of the panoramic telescope of the weapon.

★ (c) Aligns the front and rear guide stakes on the azimuth of fire so that when he guides the weapon into position the weapon will be on the azimuth of fire. In self-propelled (SP) units, the guide stops the weapon with the front roadwheel parallel to the front guide stake. This causes the panoramic telescope of the weapon to be over the hole left by the pantel marking stake. The proper emplacement of the pantel marking stake and guide stakes for SP units is shown in figure 4-7 and, for towed units, in figure 4-8.

★ (d) Receives and records the deflection to his pantel marking stake as read by the GSG.

★ (e) Paces the distance from his howitzer position to the aiming circle and reports the paced distance to the GSG. He doublechecks the paced distance by pacing back from the aiming circle to the pantel marking stake. Another means of determining distance from the aiming circle to each howitzer position is the subtense method. When this technique is employed—

The gun guide positions a 2-meter subtense bar (marked aiming post) over the pantel marking stake.

The GSG measures the subtended angle with the aiming circle, then records that angle next to the initial deflection for the position.

The BOC representative, using the subtense tables, converts the angles (provided by the GSG) into distances. (See chapter 9 for detailed procedures.)

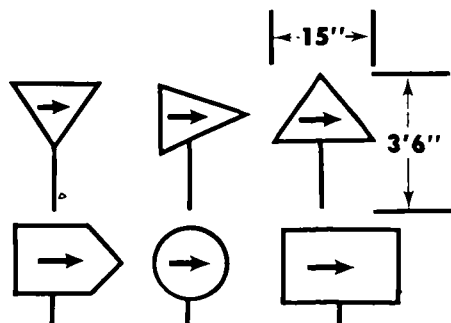


Figure 4-6. Pantel marking stakes.

Note. The arrow on each stake indicates the azimuth of fire.

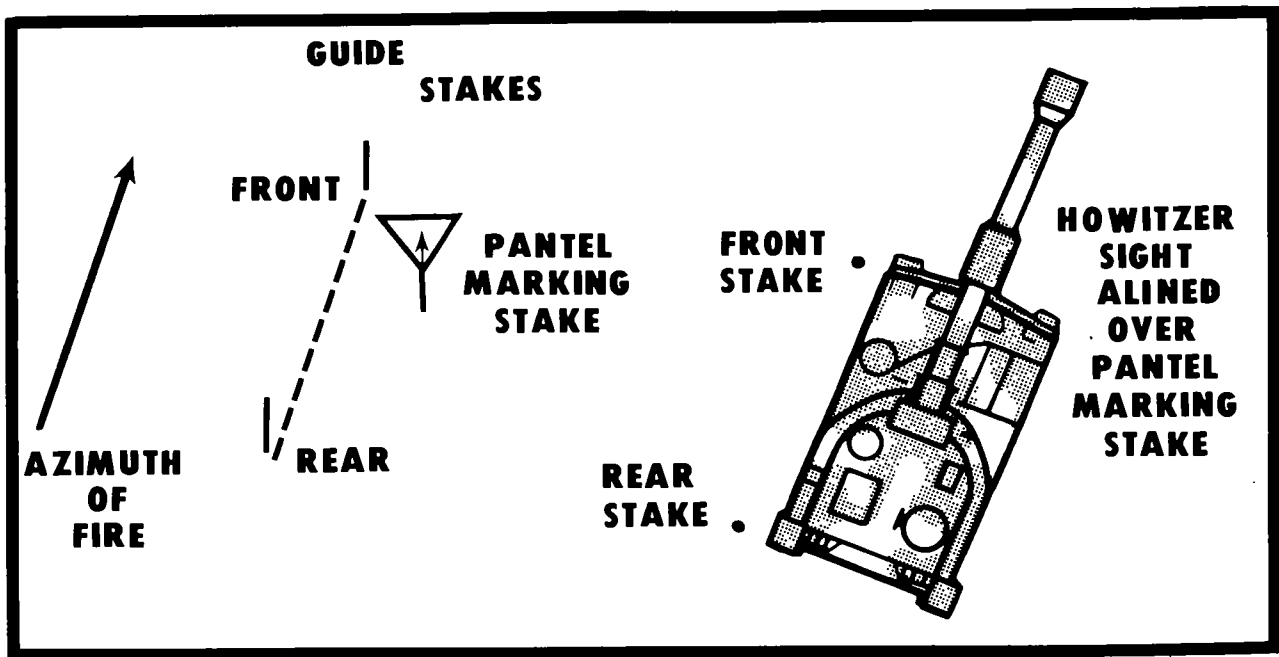


Figure 4-7. Use of stakes for SP weapons.

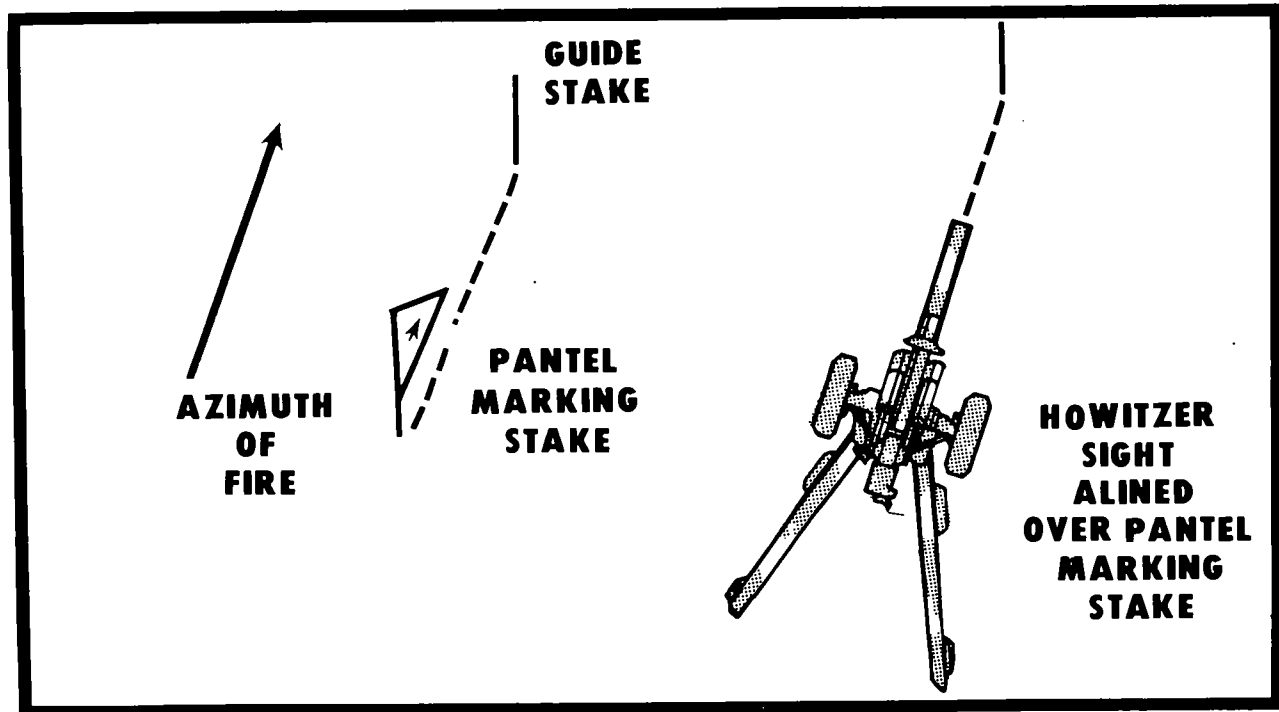


Figure 4-8. Use of stakes for towed weapons.

★ (f) After completing preparation of the cannon positions, the gun guides take up a defensive position as directed by the first sergeant. Prior to the main body's arrival, the first sergeant assembles the guides at the pickup point to meet the battery.

★ (4) The BOC representative sets up a firing chart as soon as the BC gives him the coordinates of the battery center and the azimuth of fire. If time permits, he also plots piece displacement on the M17 plotting board. When the subtense method is used to

determine distance from the aiming circle to each howitzer position, he uses the subtense tables (see chapter 9 for detailed procedures) to convert the angles recorded by the gunnery sergeant into distances.

(5) The 1SG establishes the track plan, organizes the vehicle dispersal area, selects a position for each element in the service area, and plans the defense of the position. In forming the track plan, he considers the following:

(a) Existing roads and trails are important.

(b) The entry point to the position should be in the rear and at a location where foliage, trees, or other growth meets the main road or trail.

(c) Separate exit and entrance routes should be provided.

(d) Routes should follow natural terrain features such as gullies and tree lines and take advantage of natural overhead cover and concealment.

Vehicle guides are briefed on the track plan. If concealment is critical, the 1SG may dictate the exact route each vehicle is to follow. In SP units, situations in which sharp pivoting will disrupt ground cover must be avoided.

- ★ (6) The communications representative establishes internal wire communications. He emplaces the SB-16 to the center rear of the line of metal and has the appropriate advance party personnel run lines to it, or he runs a hot loop. Whichever method is used, his first priority is to insure internal wire communications are rapidly available to the aiming circle, cannon positions, and the BOC, as a minimum. His second priority is to establish communications with outposts and make drops at locations the first sergeant indicates, such as the FDC, FSL, and mess.

★4-7. Limited Time Preparations

a. When time available to the advance party for preparing a position is limited, the battery commander must establish a priority

of tasks to insure that actions necessary to facilitate the battery's mission are accomplished.

As a minimum, he must insure that:

(1) Cannon positions are selected.

(2) Aiming circle is set up.

(3) Cannon positions are prepared, to include placing of howitzer and pantel marking stakes and recording of initial deflections.

(4) Internal wire communications are established.

(5) Firing chart is set up.

b. Duties are decentralized to the maximum extent possible. As soon as the BC selects the battery center, the gun guides select precise positions for their howitzers for approval by the BC. (The gun guides must be trained to select proper positions without close supervision.)

c. One member of the advance party is left at the designated release point to guide the entire battery into position. Individual gun guides meet their respective vehicles as they approach their positions.

d. Service vehicles should be guided into position by the 1SG and the BC's driver. If necessary, vehicles may be repositioned as soon as time permits.

e. The BOC representative and the GSG conduct their normal duties to the extent that time permits.

4-8. Preparation for Night Occupation

In addition to what has already been discussed, there are other tasks that should be performed *as time permits* to facilitate a smooth and orderly night occupation.

a. The GSG and gun guides can emplace the aiming posts prior to darkness, after the gun guides have recorded the deflections from the aiming circle to their pantel marking stakes. Unit SOP must designate referred deflections for the howitzers to allow

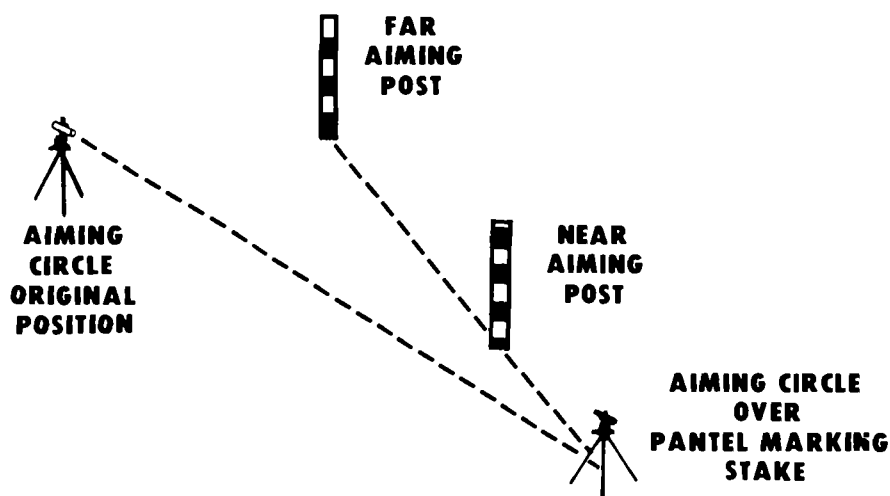


Figure 4-9. Emplacing aiming posts.

emplacement of aiming posts. The procedure for emplacing the aiming posts (fig 4-9) is as follows:

(1) After the GSG has read deflections to all pantel marking stakes, he marks the position of the aiming circle with a stake, a pole, or a section of an aiming post. (He does *not* use an aiming post section that has to be emplaced for any of the howitzers.) The GSG then proceeds to each howitzer position.

(2) He sets up, plumbs, and levels the aiming circle over the hole from the pantel marking stake over which the weapon sight will be positioned.

(3) With the *upper* motion, he sets off the deflection that he read earlier to the gun guide.

(4) With the *lower* motion, he sights on the stake (pole or aiming post section) emplaced at the original aiming circle position.

(5) With the *upper* motion, he sets off the deflection established by unit SOP for emplacing aiming posts.

(6) Sighting through the scope of the aiming circle, he then directs the gun guide to emplace the aiming posts. The night lights must be mounted and in operating condition prior to emplacement. Unit SOP should specify the alternating of red and green lights between sections.

(7) While the aiming circle is still oriented over the pantel marking stake hole, he measures the site to crest. The GSG repeats steps (2) through (7) at the remaining howitzer positions.

b. For a night occupation *every* vehicle should be guided into the position. These guides must be thoroughly briefed and should pace their routes before and after darkness. They should be equipped with filtered flashlights or have reflective tape on the back of their helmets to guide the vehicles. In many instances, assistant drivers may be used as guides for night occupation. No vehicle should be allowed to move within the position at night without a guide.

c. If tentage is used in the battery, it should be erected prior to darkness. A check for light leaks must be made. If daylight shows inside the tent, then artificial lights will show outside the tent at night.

d. Light sets and their generators may be brought forward, installed, and *checked* prior to darkness.

★ e. As with the preparation of positions for day occupations, internal wire communications must be established by the advance party, if at all possible. During a night occupation, having wire communications established prior to the arrival of the main body greatly reduces confusion during the occupation and enhances noise discipline.

CHAPTER 5

MARCHES AND MOVEMENTS

Section I. TACTICAL MARCHES

5-1. General

a. One of the essential ingredients in the delivery of timely and accurate fire is being in the right position at the right time. Getting to that position can be a difficult task. The movement of the battery must be accomplished quickly, with stealth and security. Making such a move requires considerable team training and discipline. The object of this chapter is to present information to assist in tactical vehicular marches of field artillery batteries.

b. A tactical march is the movement of a unit or elements of a unit under actual or simulated combat conditions. There are several methods of moving the battery in a tactical configuration. Each method has its specific advantages and disadvantages. It is up to the commander to decide which method or combination of methods is best in any particular situation.

5-2. Open Column Road Movement

The open column is used for normal daylight movements. It is used whenever there is an adequate road network that is not overcrowded, when enemy detection is not likely, when time is an important factor, and when there is considerable travel distance involved. Vehicle interval in an open column is generally 100 meters.

a. Advantages of this method are:

- (1) Speed (the fastest method of march).
- (2) Reduced driver fatigue.
- (3) Improved vision on dusty roads.
- (4) Ease in passing individual vehicles.
- (5) Ease in dispersing vehicles as a passive defense measure against an air attack.
- (6) Less chance of the entire unit being ambushed.

b. Disadvantages of this method are:

- (1) Greater column length requires more road space.
- (2) Other traffic often becomes interspersed in the column.
- (3) Communication within the column is complicated.

5-3. Close Column

This method of movement is similar to the open column, except that the vehicle interval is less than 100 meters. At night each driver can observe the "cat's-eyes" of the blackout markers on the vehicle in front of him and maintain an interval of 20 to 50 meters (fig 5-1). If the driver sees two marker lights the interval is too great. If the driver sees eight marker lights, he is too close. If the driver sees four marker lights, he is maintaining the proper interval.

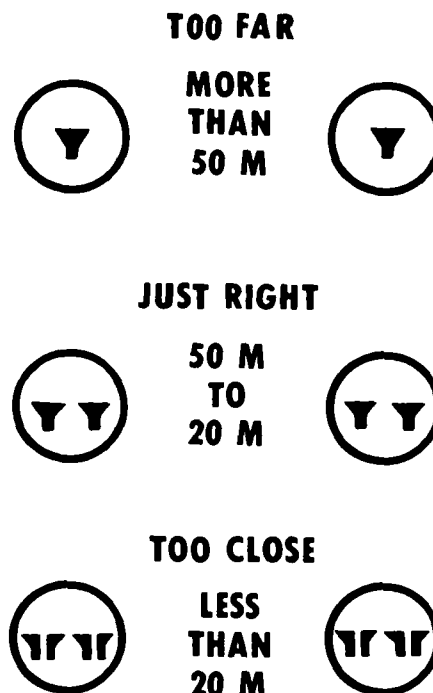


Figure 5-1. Cat's-eyes blackout markers.

During daylight the column is kept as compact as possible consistent with driving safety. The close column is used when there is a need for maximum command and control; e.g., during periods of limited visibility or when moving through built-up or congested areas.

a. Advantages of this method are:

(1) Simplicity (the simplest means of command and control).

(2) Reduced column length.

(3) Concentration of defensive firepower.

b. Disadvantages of this method are:

(1) It is very vulnerable to enemy observation and attack.

(2) Strength and nature of the column are quickly apparent to enemy observers.

(3) Convoy speed is reduced.

(4) Driver fatigue increases.

5-4. Infiltration

When the battery moves by infiltration, vehicles are dispatched individually or in small groups without reference to a march table. This technique is time-consuming, and the vehicles are difficult to control. It is used when the enemy has good target acquisition means and quick reaction capabilities. Whenever the battery mission requires stealth in moving to a new position, infiltration is the recommended method of movement.

a. Advantages of this method are:

(1) It is the least vulnerable to hostile observation.

(2) It is ideal for covert operations.

(3) It provides passive defense against air and artillery attack.

(4) It deceives the enemy as to the size of the unit.

b. Disadvantages of this system are:

(1) It is time-consuming.

(2) It is the most difficult to command and control.

(3) Small elements are more vulnerable to attack.

5-5. Terrain March

a. The terrain march is an off-road movement to reduce vulnerability of the battery and to avoid traffic tieups. The field artillery cannot afford to get caught in a traffic delay. A unit using this type of movement should travel close to tree lines, along gullies, and close to hill masses. A terrain march should be conducted when enemy observation or interdiction by artillery fire or air attack is likely. A battery may move safely on a road for some distance and change to a terrain march at a point where enemy observation becomes likely or vehicle congestion provides the enemy an inviting target.

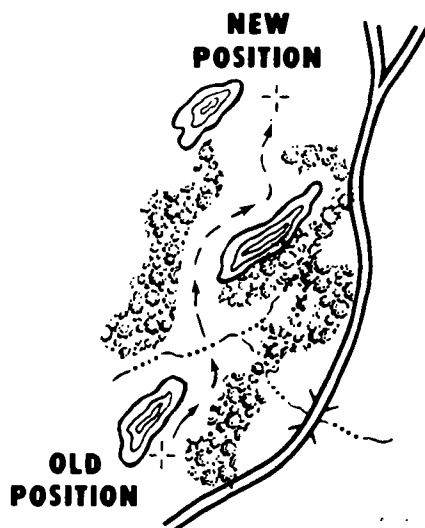


Figure 5-2. Terrain march.

b. The terrain march should be considered for traveling to alternate or supplementary positions. Careful consideration must be given to the following factors before any terrain march is conducted:

(1) Displacement time may be increased.

(2) Ground reconnaissance is required.

(3) Soil conditions may complicate this type of movement.

(4) Improper movement will leave wheel or track marks to the new position.

(5) Extensive coordination is required to avoid traveling through other unit areas.

c. The battery employing the terrain march may move in open or close column, or by infiltration. Similarly, the battery can displace either as a unit or by echelon. When it moves by echelon, part of the firing element (possibly a platoon), a portion of the command and service element, and a portion of the FDC may move in the first echelon. The

remainder of the battery may move in the second echelon. This and other combinations insure continuous fire support and can be used in a split-battery and other types of operations. A modification of this technique would be to move non-mission-essential vehicles (mess, maintenance, supply) with the battalion headquarters. These vehicles can be moved in column or infiltrated to the battery position area at a later time.

Section II. PREPARATION FOR MOVEMENT

5-6. Orders

★ The details given in a march order depend on the time, the tactical and traffic situations, and the completeness of the unit SOP. (In a fast-moving, hostile situation, orders may be verbal.) The order is given in the format of the five-paragraph field order (para 3-11) and may be supplemented by strip maps, sketches, and march tables. The principal items in a march order are—

- a. Situation.
- b. Mission.
- c. Destination.
- d. Organization, to include order of march and composition of the column.
- e. Instructions to the air observer (when applicable), reconnaissance parties, and route marking and control groups. Instructions should include place and time of departure, mission, special instructions for communications, and the time of rejoining the main body.
- f. Instructions to the main body to include the start point (SP), checkpoints (CP), designated rally point(s), the release point (RP) and times for arrival at and clearance of these points; rate of march; and the route.
- g. General instructions regarding restrictions on use of roads, maximum speed of march units, catch-up speeds, alternate routes and detours, and restrictions on use of lights and any special instructions regarding march discipline or defense against air or ground attack.

h. Communication instructions regarding the use of radio, messengers, flags, whistle or horn signals, pyrotechnic signals, and hand and arm signals.

5-7. Loading Plans

A loading plan prescribes efficient loading of personnel and equipment for movement. Each vehicle should have one. Loading plans are particularly important in sustained combat. Soldiers get tired and inattentive. They lose things. A good loading plan is insurance that a unit will close into the new position with all its equipment. The loading plan for a vehicle must be such that the equipment most essential to the mission will be loaded last. The loading plan should be recorded and graphically portrayed. Use of the loading plan is an indicator of training, discipline, and esprit de corps. If a loading plan is not prepared or specified by battalion headquarters, each battery should prepare its own. Personnel responsible for devising loading plans should consider the mission personnel, SOP, and equipment of the battery. Steps in preparing the loading plan include:

- a. Examining the battery table of organization and equipment (TOE) to determine the personnel, equipment, and vehicles authorized for each section.
- b. Examining all non-TOE property that must be transported by the battery. This equipment should be carried by the section responsible for its use.

c. Listing the personnel and equipment to be carried in each vehicle. Equipment should be located to facilitate identification under blackout conditions.

d. Conducting practice loadings to test the validity of the loading plan and adjusting the procedures if necessary.

e. Establishing a list of the items that must be removed from the vehicle and carried forward if the vehicle becomes disabled during movement.

5-8. Preparing for Movement

Preparation for the move may include:

a. Periodically starting vehicles to insure that batteries are charged and vehicles fully operational.

b. Taking up aiming posts.

c. Uncovering wire or removing it from trees.

d. Replacing section equipment in proper storage areas.

e. Reloading any off-loaded ammunition.

f. Removing overhead cover.

g. Completely loading all service elements; e.g., mess and maintenance.

CAUTION: THESE ACTIONS SHOULD NOT BE TAKEN UNTIL THE LAST MOMENT POSSIBLE. THE XO MUST KNOW HOW LONG IT TAKES HIS UNIT TO RECOVER AND BE READY TO MOVE.

5-9. Organization of the Column

The organization of the battery column varies according to the tactical situation, the threat, and the position area to be occupied. The following points should be considered:

a. In areas where enemy attack is probable, the cannons should be dispersed throughout the entire column.

☆ b. Vehicles should be arranged in an order that facilitates speedy, organized occupation of the new position, and defense during movement and occupation. In nuclear

capable units, nuclear weapon load-carrying vehicles must be located in the march column so as to provide them with maximum feasible protection and security. However, these vehicles should not have a distinctive signature.

c. If feasible, there should be two air guards per vehicle. One scans the sky forward of the vehicle while the other scans the sky rearward.

d. Machineguns should be distributed evenly through the column and should be aimed alternately to the left and right sides of the route of march.

e. Canvas should be removed as necessary to allow personnel to have their individual weapons poised to return fire if attacked. Individuals riding on the left side of a vehicle fire to the left; those on the right side fire to the right. In addition, SOP or other instructions should specify that some personnel fire on full AUTO and some on SEMIAUTO to maintain continuous fire.

f. Key personnel should be dispersed throughout the column to preclude losing a disproportionate number of these persons as a result of enemy action.

5-10. Convoy Control Measures

The following control measures assist in the movement of the battery.

a. *The start point (SP)* is normally a geographical feature identifiable on the ground and on a map. The first vehicle of a battery convoy must cross the SP at the specified start time. The battery is responsible for determining the route to the SP and the time it will take to get there. If the battery is displacing as part of a battalion move, the SP is also the point at which control of the marching element is normally assumed by battalion.

b. *A checkpoint (CP)* is normally a geographical feature identifiable on the ground and on a map. It is used in reporting progress along the route of march and may be used as a target when planning fires in defense of the convoy.

★ *c. The release point (RP) is normally a geographical feature identifiable on the ground and on a map. The last vehicle of a battery convoy must cross the RP at the specified time. The battery is responsible for determining the route from the RP to the new position area. If the battery is displacing as part of a battalion move, the RP is also the point at which control of the marching element is regained by the battery. The BC may send a vehicle from the advance party to the release point to lead the battery into the new position area.*

d. A rally point is normally a geographical feature identifiable on the ground and on a map. It is used as a point of assembly and recovery from dispersion due to enemy attack. The designated rally point(s) should

be located near or on the alternate route of march to the new position.

*e. Marking the route aids in the move. The route-marking detail marks the route by posting signs and/or personnel at those critical locations where elements of the march might make a wrong turn. Provisions are made to insure the prompt pickup of the route markers/guides when they are no longer needed. Details concerning traffic control and route marking are presented in FM 55-30 and FM 19-25, *Military Police Traffic Operations*.*

f. Predetermined signals should be established by SOP to aid in convoy control. Such items as colored flags in daylight moves and flashlights at night can aid in simple but important communications within the column.

Section III. CONDUCT OF THE MARCH

5-11. March Discipline

a. Officers and noncommissioned officers ride where they can best control and supervise the march of their units. They usually ride where they can control the vehicle driver. The senior person in each vehicle is responsible for insuring that all orders concerning the march are carried out. To supervise the move, commanders and other designated personnel may require their vehicles to pass other vehicles in the column. All other vehicles maintain their positions until otherwise directed or until circumstances dictate otherwise.

b. The column must keep moving. The unit SOP should indicate who stops to pick up mission-essential personnel and equipment if a vehicle breaks down. In most cases, the driver stays with the vehicle and the maintenance section stops to assist. If the disabled vehicle cannot be repaired in a reasonable time or recovered by the battery, the position and condition of the vehicle are reported to battalion for recovery. The maintenance section must be prepared to proceed along the route of march independently as soon as possible in order to be available to the remainder of the battery. Accordingly, the maintenance section must

have a map and must be thoroughly briefed concerning the route of march.

c. Each vehicle commander is responsible for watching for signs, markers, signals, and other traffic. He is also responsible for insuring that the driver is alert at all times.

d. March discipline is attained through training and through internal control within the marching unit. The specific objective of march discipline is to insure intelligent cooperation and effective teamwork by march personnel. Teamwork includes:

(1) Immediate and effective response to all signals.

(2) Prompt relaying of all signals.

(3) Obedience to traffic regulations and to the instructions of traffic control personnel.

(4) Use of cover, concealment, camouflage, dispersion, radio listening silence, blackout precautions, smoke, and other protective measures against air, ground, armor, and chemical, biological, or nuclear attack.

(5) Maintenance of correct speeds, positioning, and intervals between vehicles within the column.

- ★ (6) Ability to recognize route marking signals/signs.

(7) Use of correct procedures for handling disabled vehicles.

5-12. Halts

a. During administrative marches, halts are made at regular intervals or at selected sites to rest personnel, to service the vehicles, and to check the loads. Normally, halts are not scheduled for tactical marches.

b. During extended vehicle marches (1 or 2 days) from rear areas to the main battle area, wooded areas and winding roads should be selected as halting places, since they provide concealment and do not present a straight line of vehicles for attack by enemy aircraft. During extended marches, halts should be made where vehicles can be dispersed off the road. Crossroads, railroads, and other similar places should be avoided. A column should be halted in an area that provides a 200-meter clear view of approaching traffic at each end of the column.

5-13. March Column Contingencies

a. Immediate action procedures. Because of the destructive power of field artillery, a battery must always assume that it is a very high priority target for the enemy. The nature of our weapon systems makes us most vulnerable to all kinds of attack while moving. If a battery establishes an SOP for immediate actions, based on what the individual section/vehicle is to do if attacked on the march, it can greatly decrease this vulnerability to attack. In establishing immediate action procedures, the BC or XO should consider—

- (1) The enemy situation—what he can expect to be attacked with.
- (2) His organic resources for countering the different types of attack.
- (3) The nonorganic support available to him for countering attacks.
- (4) The amount of time available for training the battery in the particular immediate actions (e.g., infantry squad tactics in response to a blocked ambush).

(5) The type of communications to be employed with the immediate actions—flags, radio, arm and hand signals, etc.

(6) How best to protect the battery.

(7) How best to neutralize the attack.

b. The march column under artillery attack. The immediate action in defense against hostile artillery fire is to *move out of the danger area*, report the situation to higher headquarters, and request immediate counterfire. If a battery expects hostile artillery fire during the march, it can reduce its vulnerability by moving—

- (1) By open column or infiltration.
- (2) Under the cover of darkness or during other periods of reduced visibility.
- (3) By terrain march.

c. The march column under air attack. In the event of an air attack, the battery should engage the aircraft immediately with all air defense weapons available in the column and simultaneously disperse off both sides of the road and halt. A high-performance aircraft cannot be engaged effectively by leading it with low-volume, independent small arms fire. As the aircraft approach, everyone fires their weapons in the air to form a wall of bullets through which the aircraft must fly. For a detailed discussion of individual engagement techniques, see TC 23-44. The battalion Redeye section should have a copy.

d. Roadblocks. If the battery is halted by a roadblock, the maximum amount of fire power available, including howitzer direct fire, should be placed immediately on the roadblock and both sides of the roadblock. If nonorganic support, such as close air support, covering artillery or armor is available, it should be called on immediately to assist. If the roadblock cannot be neutralized, a disengagement must be effected under cover of supporting fires. The battery should, upon disengaging, meet at a designated rally point and resume its march using an alternate route. An attempt to crash through roadblocks with vehicles before it is checked for mines may result in unnecessary loss of equipment and personnel and a

- ★ complete blocking of the road by disabled vehicles.

e. Ambush.

(1) There are two types of ambushes—blocked and unblocked. Both must be countered in the same manner—*get out of the kill zone* and neutralize the ambushing force with firepower.

(a) *Blocked ambush.* If the route is blocked, maximum available fire should be placed immediately on the attacking forces. Personnel in the kill zone should immediately *dismount* and *attack* as infantry. Staying in the kill zone is the worst thing to do. The portion of the battery that is not in the kill zone must also *react immediately*. There are few ambushing forces that can equal the organic firepower of an artillery battery. *Use the howitzers* to place direct or indirect fire on the ambushing force (this should be SOP so that there is no delay while awaiting orders). Then roll up the flank of the ambushing force.

(b) *Unblocked ambush.* In an unblocked ambush, the battery should increase its speed and move through the ambush area while placing the maximum amount of small-arms and automatic weapons fire on the attackers.

(2) A consideration in employment of the howitzers' main armament from the kill zone is that the targets may be too close for proper fuze action. Only the 105-mm APERS (Beehive) round can be set for muzzle action to engage targets close to the weapon.

(3) If the area was identified during the map inspection as a likely ambush site, on-call fires are executed. Otherwise, a fire request is sent immediately to the battalion FDC.

(4) If the ambush or any other enemy action is of such magnitude as to cause the column to be broken up, individual elements should proceed to the new position or designated rally points on their own.

Section IV. MISCELLANEOUS

5-14. Training

a. Training in convoy operations and counterambush measures should conform to the unit SOP. This will help insure that personnel are adequately trained to cope with situations that may confront them. Some considerations for establishing a training program are:

(1) Establish a realistic movement SOP. It should conform to battalion SOP and cover, as a minimum, the following:

(a) Approval authority for displacing the battery.

(b) Duties of convoy commanders.

(c) Convoy organization.

(d) Weapons and ammunition to be carried.

(e) Hardening of vehicles.

(f) Protective equipment to be worn by personnel.

(g) Preparation of vehicles (detailed instructions regarding tarpaulins, windshields, and tailgates).

(h) Counterambush action.

(i) Drills in reaction to air or artillery attack.

(j) Security measures.

(k) Maintenance and recovery of disabled vehicles.

(l) Any scheduled refueling and/or rest halts.

(m) Establishment of rally points.

(2) Stress estimating and maintaining the specified interval between vehicles especially if the column halts. Put interval marking signs on your motor pool exit to assist drivers in training.

(3) Teach the drivers to habitually evaluate the terrain in light of the cross-country mobility of their vehicles. Even in a

well-developed area with a good road net, a driver may be required to make an off-road detour to bypass a roadblock or a section of damaged highway. The habit of constant terrain evaluation enables him to make a quick decision and select the most practical route, promptly.

(4) Practice terrain movement in small elements.

(5) Practice immediate action and critique it on the scene. Include vehicle breakdowns, equipment transfer, and vehicle repair/recovery in this action. (Many items in this area can be committed to your SOP.)

(6) Practice blackout movements to accustom the drivers to using the blackout lights. As they become proficient, restrict them to "cat's eyes" only.

★ (7) In nuclear-capable units, special situations such as defense, evacuation, trans-loading, and emergency destruction of nuclear weapons being transported in a tactical convoy should be an integral part of battery training.

b. Here are some tips for increasing the battery capability to conduct rapid and secure tactical vehicle marches.

(1) Do not limit training to those times when the entire battery is available. Whenever two or more vehicles are going to the same destination, conduct the movement as a tactical march.

(2) Find out how fast the battery can travel, both on and off the road, without losing the slowest vehicles. (Putting the slowest vehicles up front will automatically pace the column.)

(3) As a planning guide, on roads and trails the battery will average 25 km per hour in an open column and 10 km per hour in a close column (at night).

★5-15. Other Movements

a. Detailed descriptions of the various other types of movements and marches (administrative, etc.) are given in the following manuals:

(1) FM 55-30, *Army Motor Transport Operations*, and FM 55-31, *Army Motor Transport Units*, which include information

on the organization of motor movements, the movement of personnel, and the planning of motor movements.

(2) FM 100-50.

(3) FM 101-10-1, *Staff Officers' Field Manual*, which includes planning guidance for movements.

b. When the battery moves by rail, air, or water, it normally moves as an element of the field artillery battalion or with a supported unit. In any case, the battery receives detailed instructions in the form of a movement order or pertinent extracts from the movement order. A warning order alerts the battery and furnishes sufficient information of the impending movement for the battery to make plans and take the necessary preliminary action. The references listed below provide adequate information for the following types of movement:

(1) Movement by rail—FM 101-10-1 and FM 55-15, *Transportation Reference Data*.

(2) Movement by air—FM 1-100, *Army Aviation Utilization*; FM 57-35, *Airmobile Operations*; FM 100-27, *US Army/US Air Force Doctrine for Tactical Airlift Operations*; FM 101-10-1; and TM 55-450-15, *Air Movement of Troops and Equipment (Nontactical)*.

(3) Movement by water—FM 101-10-1 and FM 55-15.

★5-16. International Standardization Agreement (STANAG)

a. *STANAG 2041, Operation Orders, Tables, and Graphs for Road Movements*. When the US Armed Forces operate with North Atlantic Treaty Organization (NATO) Armed Forces, the instructions in STANAG 2041 will be followed. The applicable details of this agreement and instructions are contained in FM 55-30.

b. *STANAG 2154, Regulations for Military Motor Vehicle Movement by Road*. When US Armed Forces operate with NATO, American, British, Canadian, Australian (ABCA), and Central Treaty Organization (CENTO) Armed Forces, the instructions given in STANAG 2154 will be followed. This STANAG is in appendix H.

CHAPTER 6

OCCUPATION OF POSITION

6-1. Types of Occupation

a. The manner in which the position is occupied depends on the advance party and the movement techniques used as well as on the type of occupation itself. This chapter treats three types of occupation—deliberate, hasty, and emergency. Additionally, the key functions performed in laying and readying the battery for firing and for sustaining operations are addressed.

b. A *deliberate* occupation, as the term implies, is one that has been planned. An advance party precedes the unit and prepares the position. The occupation may be during daylight hours following a daylight preparation, at night following a daylight preparation, or at night following a nighttime preparation. A common error in a deliberate occupation is allowing too much activity during preparation, thereby risking compromise before the position is ever occupied. As a general rule, the number of vehicles allowed to go forward should be severely restricted. When the tactical situation allows, a very good method of occupying a new position is to perform the advance preparation prior to darkness and the movement at night. Nighttime movement following a nighttime reconnaissance is often necessary, but it is very time consuming.

c. The *hasty* occupation allows little or no time for reconnaissance and advance preparation. It differs from the deliberate occupation mainly in the amount of time available for reconnaissance and preparation. It generally results from unforeseen circumstances and highlights the importance of the BC's planning ahead and selecting tentative positions and routes to them.

d. The *emergency* occupation, long known as the *hip shoot*, should be avoided if at all possible. However, the battery should be trained in emergency occupation techniques.

There will be no advance preparation and the procedures for occupation will be far more decentralized.

e. The remainder of this chapter will be devoted to the key elements of the actual occupation. Details on defense of the battery position and the sequence for position defense improvement are contained in chapter 7.

6-2. Deliberate Occupation

a. A guide meets the battery at the release point (RP). This guide leads the battery to the entrance of the position area, where vehicle guides are waiting to lead the vehicles to their selected locations.

b. A gun guide alines the weapon on the azimuth of lay through the use of the guide stake(s) and pantel marking stake emplaced during preparation of the position. See figures 4-7 and 4-8.

c. The gun guide announces to the gunner the deflection to the aiming circle. The guide obtained this deflection during the preparation for occupation.

d. The telephone of the howitzer is connected to the communication wire (when available) that was laid from the SB-16 during the reconnaissance.

e. The XO/GSG uses a phone connected to the SB-16 in laying the weapons. This is most important in SP units because the howitzer engines can be left running and proper cooldown procedures can be followed. As time permits, the XO verifies the lay with a second aiming circle.

f. The 1SG directs the augmentation of the security and defense of the battery area as personnel become available.

g. After the maintenance section has been positioned, has camouflaged its equipment, and has prepared its portion of the defensive position, the motor sergeant or a mechanic should contact the section chief or drivers of

each section to determine any maintenance needs resulting from the move. The BC and XO should be informed of any major problems and the estimated time needed to correct the faults.

h. Additional considerations for night occupations are—

(1) *Light discipline.* Proper preparation for a night occupation will minimize the need for lights. Vehicle blackout drive and blackout marker lights should be turned off as soon as the ground guide has begun to lead the vehicle into position. During the laying process, only the aiming circle and the weapon being laid should have any lights on.

(2) *Noise discipline.* A given noise can be heard at much greater distances at night. Keep noise at an absolute minimum while off-loading equipment and improving the position.

(3) *Time requirement.* The time for occupation is greatly increased.

(4) *Prearranged signals.* Filtered flashlights should be used to gain the attention of the XO at the RP.

(5) Each vehicle guide should know where his vehicle is in the order of march. This will enable the battery to move smoothly into position without halting the column while guides attempt to identify their vehicles.

(6) Filtered flashlights are used to lead the vehicles. Each driver must be cautioned to **STOP HIS VEHICLE WHENEVER HE CANNOT SEE THE LIGHT FROM THE GUIDE'S FLASHLIGHT.**

(7) Vehicles should not be allowed to move within the position without a guide.

6-3. Hasty Occupation

a. In a hasty occupation, day or night, the battery will require more time to occupy the position, as some preparatory tasks cannot be performed during the limited time available for the reconnaissance and selection phase. This may result in—

(1) Delay in getting the vehicles off the

route of march into the position area.

(2) Laying by voice in towed units.

(3) Increased laying time, since gun guides might not have aligned the stakes on the azimuth of fire, or obtained initial deflections from the aiming circle.

b. When the advance party has to prepare a new position at night, the procedures for deliberate occupation at night are used, but less time may be available and fewer tasks may be performed.

6-4. Emergency Occupation

a. At times an emergency may require the battery to provide immediate fire support while moving. In this situation, the XO plots the target on his map, selects a position, and by prearranged signal notifies the remainder of the battery. The XO positions his vehicle on battery center and orients it on the azimuth of fire for use as a reference point for the cannon sections moving into position. Firing data is computed either by the XO or the FDC (the FDC should have received the mission and already have the target location). As the data is being computed, the CFB/XO lays the first piece that is ready. He uses either the aiming circle, the aiming point-deflection, or the howitzer back-lay method (chapter 8). As soon as a single weapon is laid, the XO or FDC is notified so that adjustment of fire can be initiated.

b. Unit SOP should dictate how the howitzers and service vehicles disperse. Drivers should be drilled in this procedure to the point that they can act totally without commands. If the tactical situation requires the battery to remain in position after completion of the emergency mission, the vehicles should be tactically dispersed and the position prepared accordingly.

c. When the battery receives an emergency mission at night, the XO has to decide whether to occupy some position along his route or to proceed to the newly prepared position and accomplish the fire mission from there. The battery may be able to respond faster and more accurately from the new position area.

d. An effort should always be made to avoid a situation which requires a battery to pull off the road and execute an emergency mission. When possible, another unit already in position should fire the mission. The technique, however, provides a valuable training vehicle to instill and practice the need for speed, accuracy, and enthusiasm. It represents a skill in the artilleryman's trade that all batteries should be capable of performing.

6-5. Sustaining Actions

a. The training and teamwork of the unit in performing the RSOP will culminate with the battery ready to provide timely fires in a minimum amount of time after moving.

b. Once the occupation is completed and the battery is ready to answer calls for fire, sustaining actions begin. They are continuous until the position is vacated, and accomplished in the priority determined by

the battery commander. These actions include completing the position defense and those actions necessary for the battery to remain and fire from the position for an extended period of time. These actions include but are not limited to—

- (1) Camouflage improvement.
- (2) Hardening of critical elements.
- (3) Maintenance.
- (4) Refueling.
- (5) Resupply of ammunition.

c. Care must be exercised in the manner in which ammunition resupply and refueling are conducted, particularly in SP units, for they can reveal the location of the battery. If possible, the tasks should be accomplished at night.

d. Members of the advance party should *always* be prepared to leave at a moment's notice.



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★CHAPTER 7

FIELD ARTILLERY CANNON BATTERY DEFENSE

That guns will never be deserted simply because danger threatens, is a point of honor around which the artillery has largely built the solid discipline of its corps.

—S.L.A. Marshall, *"They Fought to Save the Guns"*

Section I. INTRODUCTION

7-1. General

a. Field artillery on the battlefield must provide the maneuver commander with continuous fire support while operating over wide frontages, with frequent displacements, and with reduced personnel levels. The enemy will direct actions against the field artillery to suppress, neutralize, and destroy it and to shift the balance of combat power in his favor. The fire support mission must be accomplished before all other requirements. All field artillerymen must know and apply passive and active defense measures against artillery, air, and ground attacks if they are to survive and provide flexible and responsive fire support. This chapter presents techniques, considerations, and planning factors for developing and conducting an effective battery defense. It identifies the capabilities of a field artillery cannon battery to defend itself, provides guidance to battery officers and noncommissioned officers on how to plan and execute defensive operations, sets forth battery defensive doctrine, and provides how-to-train techniques for a field artillery cannon battery to defend against hostile artillery, air, and ground attacks.

b. Realistically, there are many ways to defend a battery, and this chapter will not attempt to explain every technique. The battery commander has the option of how to defend, and he chooses the best solution to fit his circumstances. Defensive concepts vary

and may depend upon the type of unit (105-mm, 155-mm, 8-in, towed, or SP) and its assigned mission (direct support, reinforcing, general support, or general support reinforcing). For example, a battery of a direct support battalion has more direct information from its FISTs, and a towed battery cannot engage in shoot-and-move techniques as readily as an SP battery.

c. Nuclear-capable batteries must establish a field storage location in the battery position if they have nuclear weapons. Except for the security requirements established in FM 100-50, the FSL is defended like any other battery installation. It is protected by the same soldiers who protect the cannons, FDC, and BOC. Accordingly, the battery commander must include the FSL in his defense planning. He must provide timely guidance to the appropriate special weapons personnel to allow evacuation or emergency destruction of the prescribed nuclear load (PNL) if necessary to prevent it from falling into enemy hands.

d. The battery commander must use available assets to:

- (1) accomplish the primary mission of fire support,
- (2) establish a defensible position,
- (3) establish a local early warning system, and
- (4) prepare for rapid movement or defense as required.

7-2. The Threat

On the battlefield, our forces can expect to encounter a well-trained, numerically superior, and increasingly sophisticated enemy. Field artillery batteries, especially nuclear-capable ones, are priority targets for the threat. The enemy will attempt to detect, destroy, neutralize, or suppress batteries.

a. Detection is accomplished by:

- (1) Map reconnaissance.
- (2) Air reconnaissance.
- (3) Partisans/spies.
- (4) Long-range patrols.
- (5) Electronic devices (e.g., artillery-locating radars, sound and flash ranging, radio direction finders, infrared detectors, and moving-target-locating radars).
- (6) Taking advantage of our mistakes (e.g., COMSEC, camouflage, and light and noise discipline violations; failure to use infrared (IR) paint or lightweight screening system (LWSS); and unique nuclear procedures or signatures).

b. Destruction, neutralization, or suppression of battery locations is accomplished by:

- (1) Counterfire.
- (2) Air attack (e.g., high-performance aircraft and helicopters).
- (3) Electronic warfare (e.g., communications jamming and imitative deception).
- (4) Ground forces (e.g., mounted forces of tanks and motorized infantry and dismounted forces of infantry, airborne/air assault, and partisans/guerrillas).

7-3. Responsibilities

a. The basic considerations of defense apply in all situations (see para 7-4). Planning, preparing, rehearsing, and position hardening are the key elements of defensive operations in the battery area. General planning, coordination, and control are the responsibility of the battery commander. The first sergeant manages the defense program by preparing, rehearsing, and directing execution of the final plan.

b. When formulating the specific plan, the first sergeant considers the potential enemy threat, the unit personnel status, and the time and materials available to determine the type and extent of defensive positions to be prepared. He determines the final location for crew-served and antitank weapons, defines fields of fire, locates observation and listening posts, and recommends supplementary cannon positions for defense of the battery.

c. The first sergeant coordinates closely with the executive officer in selecting targets and sectors for the employment of the cannons in defense of the battery. The employment of shell HE with PD fuze on point targets, "Killer Junior" techniques (shell HE, fuze time fired at the lowest possible charge), smoke, "Beehive," and ICM for 6,400-mil coverage of the battery should all be considered. After coordinating the targets for the cannons, the executive officer determines individual firing data for each section and provides this data to the FDC and to each section. The employment of the cannons in defense of the battery is shown on the defense diagram.

d. The first sergeant must also insure that the communications required to support the plan are installed, checked, and functioning properly. After he develops the battery defense plan, the first sergeant should have the plan checked by the battery commander at the first opportunity. However, preparation of the position should not be delayed until the battery commander's approval is received.

e. Once position preparation has begun, the first sergeant supervises continuous improvement of the positions and reinforcement of the defense plan. He also insures that the small-arms and crew-served weapons ammunition resupply SOP is fully understood and complied with by all. The priority of tasks for position area improvement depends to a great extent upon guidance received by the battery commander concerning the current threat.

Section II. ORGANIZATION OF THE DEFENSE

7-4. Planning the Defense

a. The field artillery battery relies heavily on the battalion command and staff elements for initial assignment of survivable battery positions, for coordination of mutual support, and for early warning of possible attack. The battery commander must realize that his primary mission—providing fire support—is severely curtailed when the battery must defend itself. The maneuver and field artillery commanders must understand the firing battery's limitations—generally, howitzers don't win against tanks, and there is limited manpower in the battery to fight against infantry. Using surprise and terrain to his advantage, a battery commander can often even up the odds. Both the battery and battalion commanders must coordinate with the maneuver commander to insure that the most efficient and effective mutual defensive posture is developed. Survivability for the cannon battery depends on:

- (1) sound planning practices (commander's guidance),
- (2) early warning (proper coordination), and
- (3) quick action and mobility.

b. To plan the defense, the battery commander considers passive and active defensive measures. Basic defensive considerations and appropriate actions to be taken for each are discussed in paragraphs 7-5 and 7-6.

7-5. Defensive Considerations

a. Security. The enemy achieves surprise and can get the upper hand if the battery cannot respond to an attack rapidly. Good security prevents surprise attacks, and close coordination with maneuver units helps establish good security.

b. Proper use of terrain. Selecting a battery position from which the fire support mission can be accomplished is not difficult. The challenge is to select a position that is not easily detected or attacked, is easily defended, and allows mission accomplishment.

c. Defense in all directions. Normally, the enemy can attack from any direction, so the battery must be able to defend in any direction. Plans should be made to use preselected positions inside and outside the battery.

d. Defense in depth. A defense in depth conserves battery assets and provides time to mass forces at the point of attack.

e. Mutual support. Mutual support is one unit helping another unit or one soldier helping another soldier. Fires from other batteries should be coordinated for defense and for attack of long-range targets. Within the battery, one section must be ready to support another. Applying the same concept to the individual soldier can build a formidable defense. (Range cards for crew-served weapons and howitzers will insure interlocking fires.)

f. Dispersion. Personnel, fighting positions, cannons, and other battery elements should be separated so that a single attack will not neutralize all or a major part of the battery.

g. Control. The battery commander must control his personnel and firepower before, during, and after an attack. This is necessary to insure the correct actions can be taken at the right time. Battery SOPs should be developed so everybody will know what to do.

h. Priorities. Critical defensive tasks should be established and put in order of priority based on the anticipated threat.

i. Flexibility. No fight will ever go exactly as planned, and the commander must respond quickly to the unexpected. He must constantly evaluate his mission, the enemy, troops and weapons available, terrain, and weather. He must be prepared, by developing contingency plans, to deal with "unplanned" situations.

7-6. Defensive Actions

a. Recognize good avenues of approach for infantry or mechanized forces. Know enemy weapon capabilities and employment techniques. Train the unit to emplace and use early warning devices such as trip flares. Train personnel manning OPs and LPs to adjust field artillery fires and to operate a radio, a telephone, and other signal devices.

b. Select supplementary positions for howitzers to defend against armor/mechanized forces. Select engagement (kill) zones to repel armor or mechanized forces as required. Select terrain for good cover and concealment, trafficability, defilade, and early warning. Reinforce natural terrain obstacles with mines, wire, and other manmade obstacles.

c. Emphasize basic combat skills. Train sections so they can identify avenues of approach and engagement areas and know their direct fire responsibilities. In the unit SOP, establish area responsibilities within the battery on a permanent basis. A "clock" system, with 12 o'clock being the direction of fire, is a way to assign areas of defense to each section in the battery.

d. Select OPs and LPs for early warning and engagement. Train a squad-sized reaction force as an on-call reserve to attack enemy forces or to reinforce the defense. Select fighting positions that provide the best security for essential battery installations. Fighting positions should provide good protection from counterfire.

e. Plan and coordinate mutually supporting fires with key battery personnel. Use range cards to insure interlocking fires from crew-served weapons, individual fighting positions, and howitzer direct fire. Insure coordination with the maneuver commander on all firing in his area.

f. Disperse battery elements according to the threat facing the battery. A predominant counterfire threat requires greater dispersion to make a larger, thus more difficult, target for the enemy to define and attack. A ground threat requires less dispersion. Because the emphasis is on easy control of weapons and men and concentrating forces against the

point of attack, use all available cover and concealment.

g. Practice sound tactical principles in organizing and maintaining a good defense. All leaders must know what to do, when to do it, and how to do it. The individual soldier must follow guidance and SOPs and maintain proficiency with his individual weapon. He must know what is expected from him during a ground, air, or counterbattery attack.

7-7. Passive Defense Measures

Passive defense measures prevent detection by enemy target acquisition efforts and let us stay in position without having to fight against an enemy force. Some of these measures are discussed in paragraphs 7-8 through 7-13.

7-8. Planning

a. Occupy positions that have natural advantages for defense, such as interior treelines and ravines in the area.

b. Train all battery personnel so they are aware of defensive responsibilities.

c. Maintain light and noise discipline.

d. Make maximum use of natural cover.

7-9. Fortifying

a. Harden all battery positions and dig in. Although assets are very scarce, engineer equipment can be helpful in hardening the SP position. An experienced dozer operator can provide a suitable position, either dug in or bermed up. Such a position should be long enough to permit the M548 ammunition vehicle to occupy the same position, as shown in figure 7-1. However, the commander must exercise caution when hardening a position in this manner. The dirt spoil and dozer tracks must not be allowed to destroy the camouflage effort. FM 5-15, *Field Fortification*, contains good examples for hardening the towed weapon position.

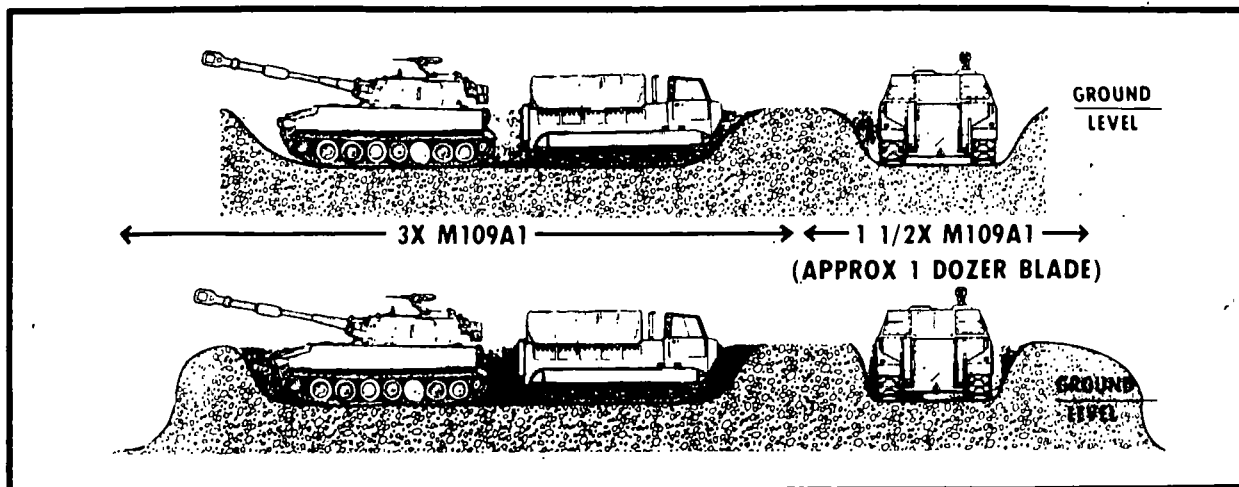


Figure 7-1. SP weapon positions, dug in and bermed up.

b. Construct obstacles to delay, stop, divert, or canalize an attack force. Time and material available will dictate the degree of construction of manmade obstacles. Maximum advantage must be taken of natural obstacles. All obstacles should be covered by fire. Types of manmade obstacles and techniques for their employment are in FM 5-15.

c. Use cover for protection from the effects of weapons fire. Both natural and manmade objects can be used. Since time usually will not permit elaborate position hardening, take maximum advantage of natural cover. In fast-moving situations, or when emergency displacement is anticipated, hardening might be limited to digging foxholes on the perimeter, burying wire, placing sandbags around sensitive equipment such as collimators and tires, and constructing individual shelters for prone personnel. If natural cover is limited or unavailable, infantry fighting positions should be constructed. See FM 7-7, *The Mechanized Infantry Platoon and Squad*, for further information.

7-10. Hiding

"If it can be seen, it can be hit. If it can be hit, it can be killed." If a battery is concealed, does not reveal its location, and cannot be recognized, its odds for survival are greatly increased.

a. To minimize its chances of discovery, the battery must:

- (1) Conceal all battery equipment and personnel. Use track plans to conceal movement.
- (2) Keep civilian or unidentified military personnel out of the battery area.
- (3) Exercise fire discipline for small arms.
- (4) Reduce movement within the battery area.
- (5) Reduce movement in and out of the battery area.
- (6) Keep radio traffic to a minimum. Signal security (SIGSEC) is the key word for hiding. Radios give away positions.

b. To avoid detection, the battery must be disguised or hidden. There are six factors of recognition: position, color, shape, shadow, texture, and movement. Two artificial camouflage measures that can reduce or eliminate the chance of recognition are pattern painting of equipment with the approved four-color patterns and proper use of the lightweight screening system (LWSS). Use of these measures and the principles of concealment—siting, camouflage construction, and camouflage and light and noise discipline—help the battery avoid detection.

(1) *Principle 1*—site equipment.

(a) Properly site electronic equipment to reduce signatures, and site all battery equipment to eliminate exposure and the possibility of detection.

(b) Make use of all camouflage. Put vehicles in places that keep them hidden. Trees and shrubs can hide batteries. Built-up areas are great for hiding equipment, because there, manmade items look like other manmade items and do not contrast with natural surroundings. Sand or snow can be used to hide equipment.

(c) Use whatever terrain and natural concealment are available in the area and try to blend into the surroundings.

(2) *Principle 2*—construct camouflage. After the equipment is sited, erect LWSS immediately to cover the piece of equipment and the working (or crew) area. Use camouflage material that matches the surroundings. Do not use oak branches from the last position that do not match the pine trees in the new position. Do not break up natural "up and down" living tree patterns with manmade patterns (lines). Natural materials (if cut) will soon die and give away a position.

(3) *Principle 3*—maintain camouflage and light and noise discipline.

(a) Carelessness or failure to maintain camouflage discipline ruins the whole camouflage effort. Light and noise discipline must be enforced continuously. After you think everything is well sited and well camouflaged, step back and closely study the camouflage area. If you see anything that looks contrived or unnatural, or if the six factors of recognition have not been eliminated, the enemy will see the same thing. The appearance of the area should not be changed. Each individual in the battery must be careful not to disclose the presence of military activity. Noise and light discipline are two of the more common problem areas. They both are particularly important at night. Noise draws attention and can be identified. Light leaking from a tent is a target for direct fire weapons.

(b) The most common signs of military activity in an otherwise well camouflaged area are tracks, spoil, debris, and movement. The battery commander must enforce his track plan. Existing roads and trails must be used. If none are available, some should be created with heavy vehicles to give the appearance that a unit has moved through the area (the roads and trails must have logical starting and terminating points). Spoil from position hardening must be camouflaged. Debris from expended ammunition and the mess area must be policed up and camouflaged. Shine from headlights, windshields, mirrors, and mess equipment can be eliminated easily with scrap canvas, sandbags, and paint, as appropriate. Even the signature of smoke generated by the mess section's stoves can be reduced by restricting use to periods between dusk and dawn.

(c) Supervisors should read FM 5-20, *Camouflage*, for more information.

7-11. Deception

No matter how well the battery is hidden, the signature of firing cannot be disguised. The object of deception is to make the enemy direct his counterfire efforts to the wrong area. Two means of deception are the dummy position and the roving gun.

a. *Dummy position.* Permission must be obtained from higher headquarters before a dummy position is established. These positions should be established only in areas where counterfire will not cause friendly casualties. Techniques for establishing a good dummy position are:

(1) Establish obvious vehicle tracks leading into the dummy position.

(2) Use logs, dead trees, or stove pipe sections to simulate cannon tubes.

(3) Place soil around the position as if a fighting position has been prepared.

(4) Make crude attempts to camouflage the position.

(5) Place discarded equipment and trash around the dummy position.

(6) Regularly conduct radio transmissions from or near the dummy position area.

(7) Use the position as an offset registration position or as a roving gun position.

b. Roving gun. One weapon of the battery can operate away from the battery area. This roving gun moves frequently, since its location will likely be compromised once it has fired a mission. The purpose of using a roving gun is to reduce the amount of fire from the battery position to avoid disclosing the position to the enemy target acquisition means. Also, it may cause the enemy to direct his counterfire to the dummy position. Some considerations in employing the roving gun are:

(1) Fire direction and command and control capability should move with the roving gun.

(2) The number of missions fired from the same position should be limited.

(3) The roving gun should be positioned so that counterfire does not hit other friendly forces.

(4) An unacceptable reduction in firepower may be caused by pulling one weapon out of the normal firing position.

7-12. NBC Defense

Tactical chemical defense plans must be integrated into the cannon battery defense plan. The battery commander should consider the following:

a. The capabilities of enemy weapons and chemical munitions.

b. The effect of weather and terrain on chemical agents.

c. Availability and serviceability of unit chemical defense equipment.

d. The effects that wearing of chemical protective clothing and masks will have on unit personnel and accomplishment of the unit mission.

e. The level of mission-oriented protection posture (MOPP). His decision is based on the chemical threat, mission of the battery, type of activity required, and temperature. Ultimately, casualties from enemy chemical attack are minimized through thorough training and proper planning. Individual and collective measures for defending against NBC attack are detailed in FM 21-40, *NBC Defense*. The protective measures discussed in this reference must be considered with the passive and active defense measures discussed in this chapter.

7-13. Operations Security (OPSEC)

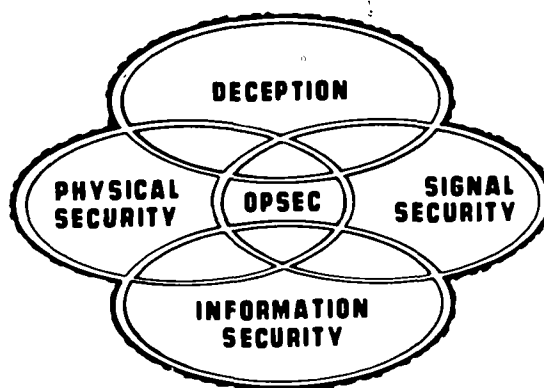


Figure 7-2. OPSEC measures.

In addition to using cover, concealment, and camouflage, battery personnel must practice signal security and overall operations security (fig 7-2). To collect information about our activities, the enemy uses people to gather information (HUMINT); devices to intercept our signal emitters (SIGINT); electronic warfare (EW) assets to intercept, direction-find, jam, and deceive; and photographic equipment (PHOTINT). Battery personnel can minimize vulnerability to detection and better insure survivability by employing the following countermeasures against the threat:

a. Signal security. Proper use of communications counters SIGINT and EW.

(1) Use radios only when necessary. Impose radio silence when possible.

(2) Use wire.

(3) Use proper radio operation procedures.

(4) Remote radios to reduce signature.

(5) Use directional antennas. Field expedients can help.

(6) Practice good communication security (COMSEC) techniques.

b. Deception. Proper use of gunnery techniques can aid in deception.

(1) Register from offset positions.

(2) Register to the rear.

(3) Use roving guns.

c. Physical security. Proper physical preparation of positions counters the PHOTINT and HUMINT threat.

(1) Use LWSS and pattern painting.

(2) Use natural camouflage and terrain positioning.

(3) Insure good light and noise discipline.

(4) Use LPs and OPs.

(5) Use dummy positions (as approved).

d. Information security.

(1) Enforce light and noise discipline.

(2) Clear any signs of vehicle movement in and out of positions.

7-14. Active Defense Measures

Active defense measures are those used by the commander to prepare to fight or disengage from the enemy if the battery is detected. Defensive operations should be planned so that the battery commander will be warned of an impending attack in sufficient time to displace his unit or to defend the position. In either case, the defense must protect the unit against air, ground, and artillery attack from all directions. When establishing a perimeter defense, it is critical to coordinate with adjacent units to provide mutual support and to preclude firing into a friendly position.

a. Active defense measures that a battery can use include:

(1) Selecting fighting positions.

(2) Planning and coordinating supplementary positions, alternate positions, and defensive fires.

(3) Preparing immediate actions against ground attacks from either small reconnaissance units or armor forces.

b. Observation/listening posts (OP/LP), antitank positions, and supplementary positions (fig 7-3) must be selected and coordinated with the maneuver commander in whose area of responsibility the battery has been positioned.

(1) OPs/LPs are key elements for early warning and are absolutely necessary for the firing battery defense. How far they are located from the battery area depends on terrain, visibility, likely threats, and how much time the battery requires to displace or occupy preselected fighting positions. Site OPs to observe likely avenues of approach into the battery area so you can attack the enemy at long range with artillery, mortars, or close air support. Man OPs with at least a two-man team, and provide them with antitank weapons and communications. Select firing positions away from the OPs to engage the enemy with antitank weapons, because OPs are not always located in good positions for attacking armor elements.

(2) Antitank positions are used to delay the enemy and allow the battery time to prepare to engage or to displace. Select these positions along routes that allow the antitank teams to attack at close range with surprise flanking fires. (A detailed description of the antitank positions is in paragraph 7-19.) Plans should be made for the use of mines and other obstacles along the avenues of approach. OPs and LPs provide early warning and detection of enemy movement near the battery area. Select listening posts and fighting positions away from battery installations and orient them on avenues of approach. They may be strengthened fighting positions, or they may

be minimally prepared positions. In combination, LPs and OPs form a security zone around the battery area. Communications among these positions should be by wire, radio, or visual signals. LPs and OPs on critical avenues of approach are manned continuously. Other LPs and OPs are manned based on the intelligence data available and the resources of the battery.

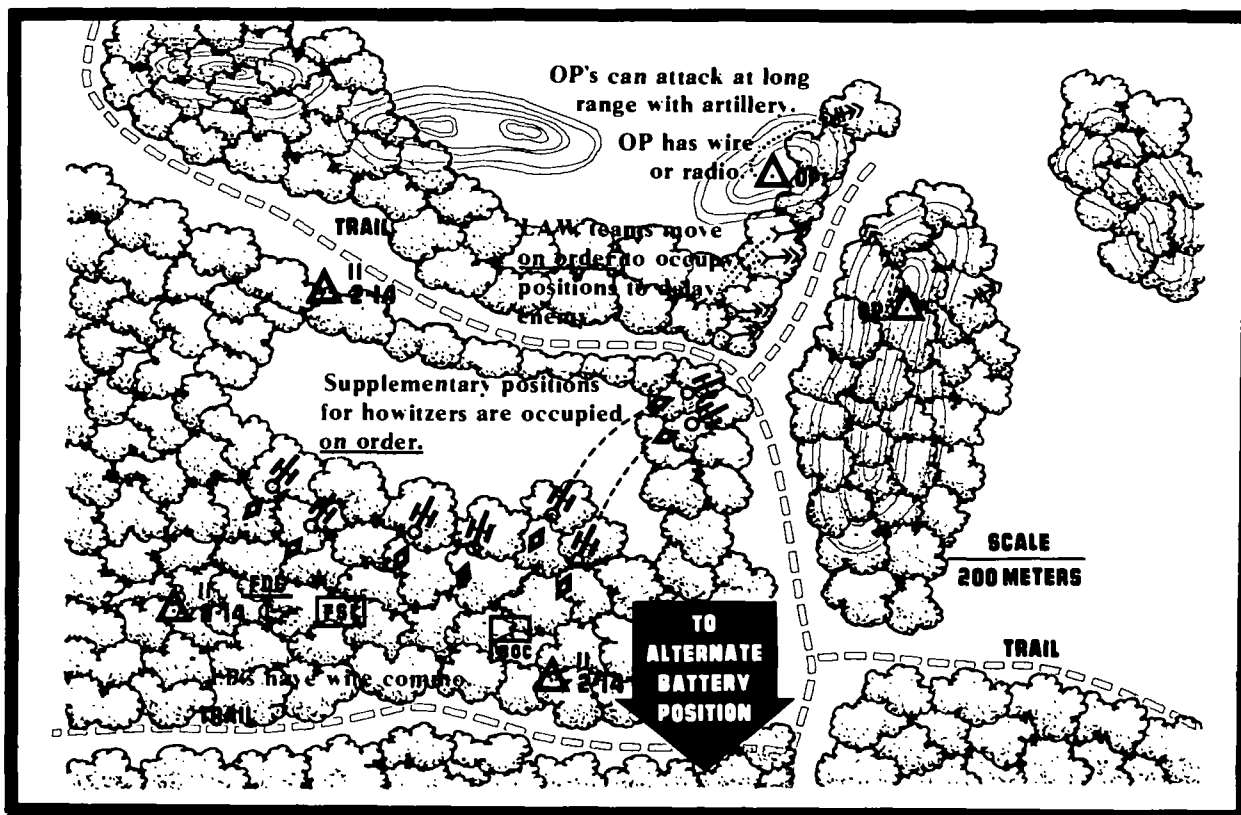
(3) Supplementary positions are selected for howitzer direct fire against attackers. These supplementary positions are supported with fighting positions that provide interlocking protective fires. The battery commander must insure that all sections know the alternate battery position in order to assemble the battery after an emergency displacement.

7-15. Night Defensive Measures

a. Since night operations are likely, the battery must plan defensive measures to counter the effects of darkness and the enemy's tactics for night fighting. The enemy will conduct night operations in much the same way he conducts daylight operations. He prefers to conduct deliberate attacks at night. As in a daylight operation, he wants to—

- (1) destroy opposing forces,
- (2) create confusion, and
- (3) destroy weapon systems.

b. The emphasis is on creating confusion and preventing a coordinated effort. To counter the threat, the field artillery battery must use:



Notes.

1. A KZ, or killing zone, is a predetermined area into which the defender wants to canalize and attack the enemy.
2. OPs and LPs may not necessarily be positioned in the same location.

Figure 7-3. Example of battery positions.

(1) LPs and OPs for early warning at night.

(2) Organic night vision devices (see table 7-1).

(3) Radars to provide information to the battalion S3 that can be passed on to the batteries (see FM 6-20).

(4) Early warning devices, such as trip flares.

(5) Illumination, which must be coordinated with the maneuver elements before it is used. Consider all possible sources of illumination—pyrotechnic, mortar, field artillery, and searchlight.

c. None of these devices alone can provide adequate security, but used in combinations as determined by the battery commander, they can provide the early warning necessary for defense.

d. Successful night fighting is the product of sound training. Current ARTEPs give appropriate tasks, conditions, and standards peculiar to night operations. The battery commander must use and integrate all of the assets available—night observation devices, trip flares, illumination (self-illumination or coordinated illumination), OPs, and LPs.

Table 7-1. Battery Defensive Resources

Mines That May be Allocated to a Cannon Battery		
MINE	TYPE	REF RANGE/RADIUS
M15	Antitank	
M16	Antipersonnel	30 m
M18 (Claymore)	Antipersonnel	50 m
M19	Antitank	
M21	Antitank	
Note. Source is FM 101-10-1.		

Weapons That May be Available for Mutual Support	
WEAPONS	MUNITIONS
Cannons (indirect fire)	DPICM, HE/VT, Q, smoke, illumination
Attack helicopters	TOW, 2.75-in rockets, MG, 40-mm and 20-mm cannons
USAF tac air	Guns, bombs, rockets, napalm, missiles (Maverick), guided bombs, cluster bombs (all varieties)
Mortars	HE, smoke, illumination
Naval gunfire (NGF)	Armor piercing, HE/VT, Q, WP, and illumination

Night Observation Devices (NOD) in Firing Batteries				
	No. in 105 Btry	No. in 155 T Btry	No. in 155 SP Btry	No. in 8-In Btry
AN/PVS-5 (Night vision goggles)	6	6	6	5
AN/PVS-4 (Individual sight)*	4	4	4	4

Table 7-1. Battery Defensive Resources —continued

WEAPON	**ISSUE/CALIBER	MAXIMUM EFFECTIVE RANGE	REFERENCE	NOTES
M16	1 per indiv	460 m	FM 23-9	May select full automatic or semi-automatic fire.
M203 grenade launcher	Per TOE	400 m (area), 200 m (point)	FM 23-9	M433 HEDP excellent against pers carrier.
M60 LMG (tripod mtd) (air defense)	1 per section (Exception. None in M109 series sections)	1,100 (600 m grazing fire) 325 m	FM 23-65 FM 23-67	
M2 (HB) (50 cal) (tripod mtd) (ring mtd) (air defense)	1 or 2 per how sec(SP)	2,430 m (area), 1,800 m (point) 1,500 m (area); 1,000 m (point) 725 m		Best used on tripod with traverse and elevating mech.
M72 LAW (tgt stationary) (tgt moving)	(Issued as ammunition)	250 m 100 m	FM 23-33 TRADOC Bulletin 5	Employ in pairs.
Cannons Direct fire (antipers) Killer Junior (HE/Ti) Beehive (M456) Direct fire (antitank) HE/Q HEP, M327	8-in/155-mm 105-mm 8-in/155-mm/105-mm 105-mm	Minimum reliable range 500 m + Muzzle + (See TM on weapon system) (See TM on weapon system) (See TM on weapon system)		
Redeye surface-to-air		3,000		Teams assigned from battalion.

*Use 1 for every two M60 machineguns.

**Basis of issue for items will vary according to type unit.

7-16. The Defense Diagram

Upon occupying a position, each section must have a predetermined sector of responsibility that makes maximum use of the section's primary weapon(s). As soon as practical, the battery commander should evaluate the defensive plan by studying the defense diagram. He insures that there is a coordinated all-around defense, with interlocking fires from available weapons to insure there are no gaps in the defense. (See table 7-1 for defense resources available to the battery.) The defense diagram is a sketch, drawn to scale, of the battery defensive resources. It is based on the data from each howitzer and machinegun range card and includes the fields of fire for other weapons such as grenade launchers, antitank weapons, and individual weapons. The diagram is prepared by the first sergeant and approved by the battery commander. A copy is provided to the battalion CP.

a. Equipment required. To construct the defense diagram, use a 1:50,000 map of the area, a coordinate scale, a protractor, overlay paper, and a blank 1:25,000 grid sheet.

b. Construction of the matrix.

(1) Locate the battery center on the 1:50,000 map. Identify the grid square or squares that contain the terrain features that influence the defense of the battery position.

(2) Place tick marks at 200-meter intervals along the sides of the selected grid squares (fig 7-4).

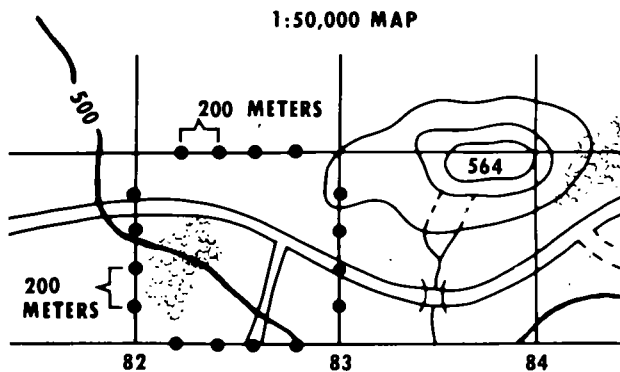


Figure 7-4. Tick-marking the grid square.

(3) Connect the tick marks to form 200-by 200-meter squares within each grid square (fig 7-5).

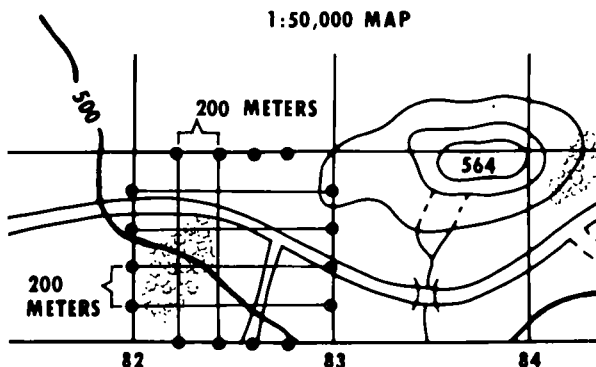


Figure 7-5. Forming the matrix.

(4) Label the squares beginning at the lower left of the grid square. Number the lines to the right and up, as you would read a map (fig 7-6).

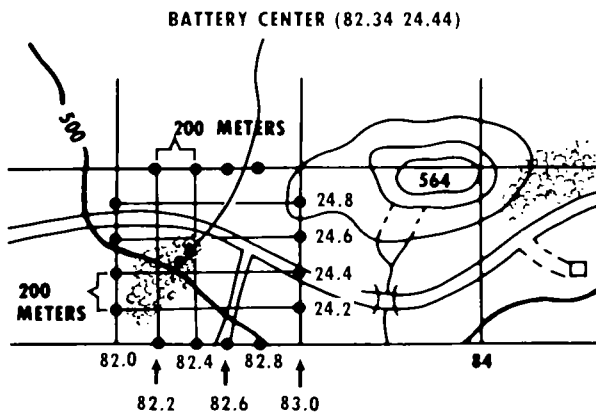
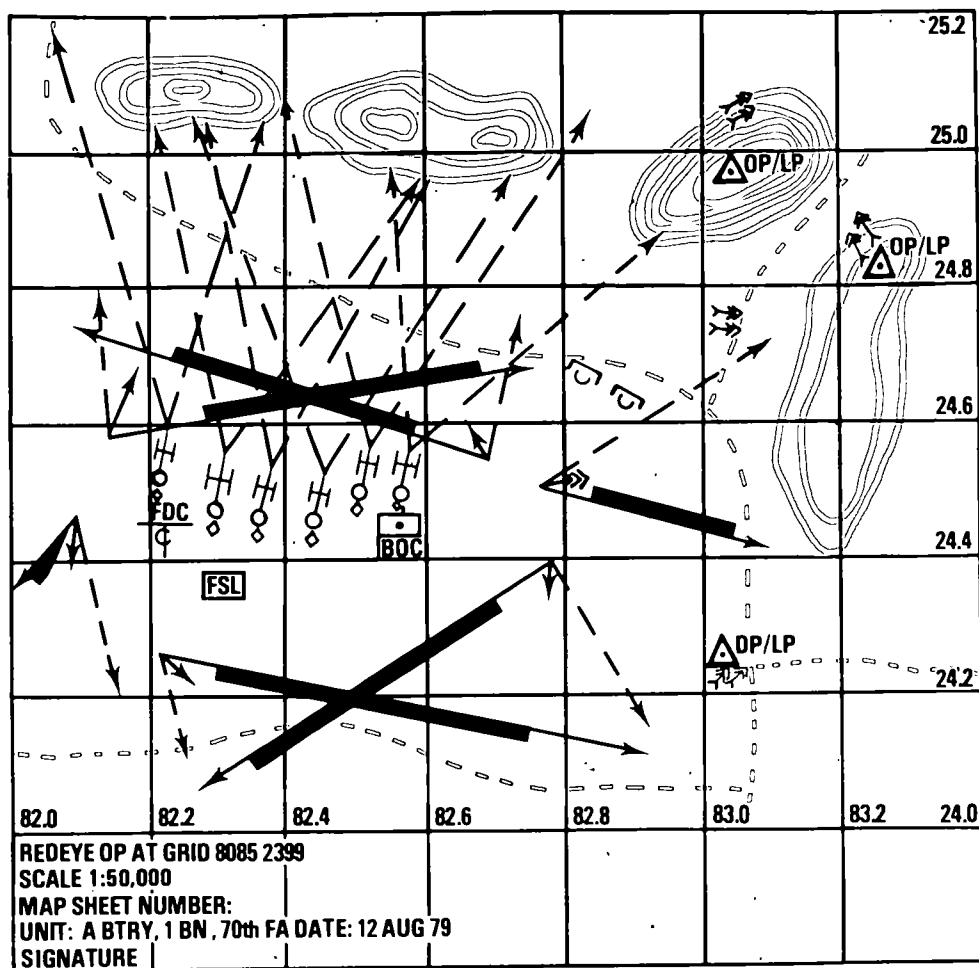


Figure 7-6. Labeling the matrix.

(5) Expand the scale to 1:50,000 by using a blank 1:25,000 grid sheet. In expanding the scale to 1:50,000, each 200-by 200-meter block within the matrix correlates with a 1,000-meter grid square on the 1:25,000 grid sheet. Determine which 200-by 200-meter block on the matrix contains the battery center. In figure 7-6, it is 82.2 24.4. Next, select a square near the center of the blank grid sheet, and label this square the same—82.2 24.4. You have identified and labeled the 200-by 200-meter block where the battery center is located. From that point, duplicate the labeling from the matrix on the grid sheet.

(6) Reproduce key terrain. Examine the 200- by 200-meter blocks on the 1:50,000 map that contain key terrain features that influence the defense. Sketch what you visualize in these blocks on the corresponding squares of the 1:50,000-scale grid

sheet. The result will be a map reproduction minus the contour lines and other data not pertinent to the defense of the battery (fig 7-7). However, contour lines representing hills or depressions may be included if they are deemed pertinent.



Notes.

1. Battery shown is 155-mm SP, occupying terrain in figure 7-3.
2. See FM 21-30 (or STANAG 2019) for military symbols used in defense diagrams.
3. Symbols used above:

↑ = LAW

↑ = Light MG

⚡ = heavy MG

$$\Delta = OP/LP$$

$\mathcal{T}$ = Wirehead

$\boxed{\cup}$ = unoccupied position (supplementary)

 = medium SP artillery.

 = battery command post/(BOC)

Figure 7-7. Completed defense diagram.

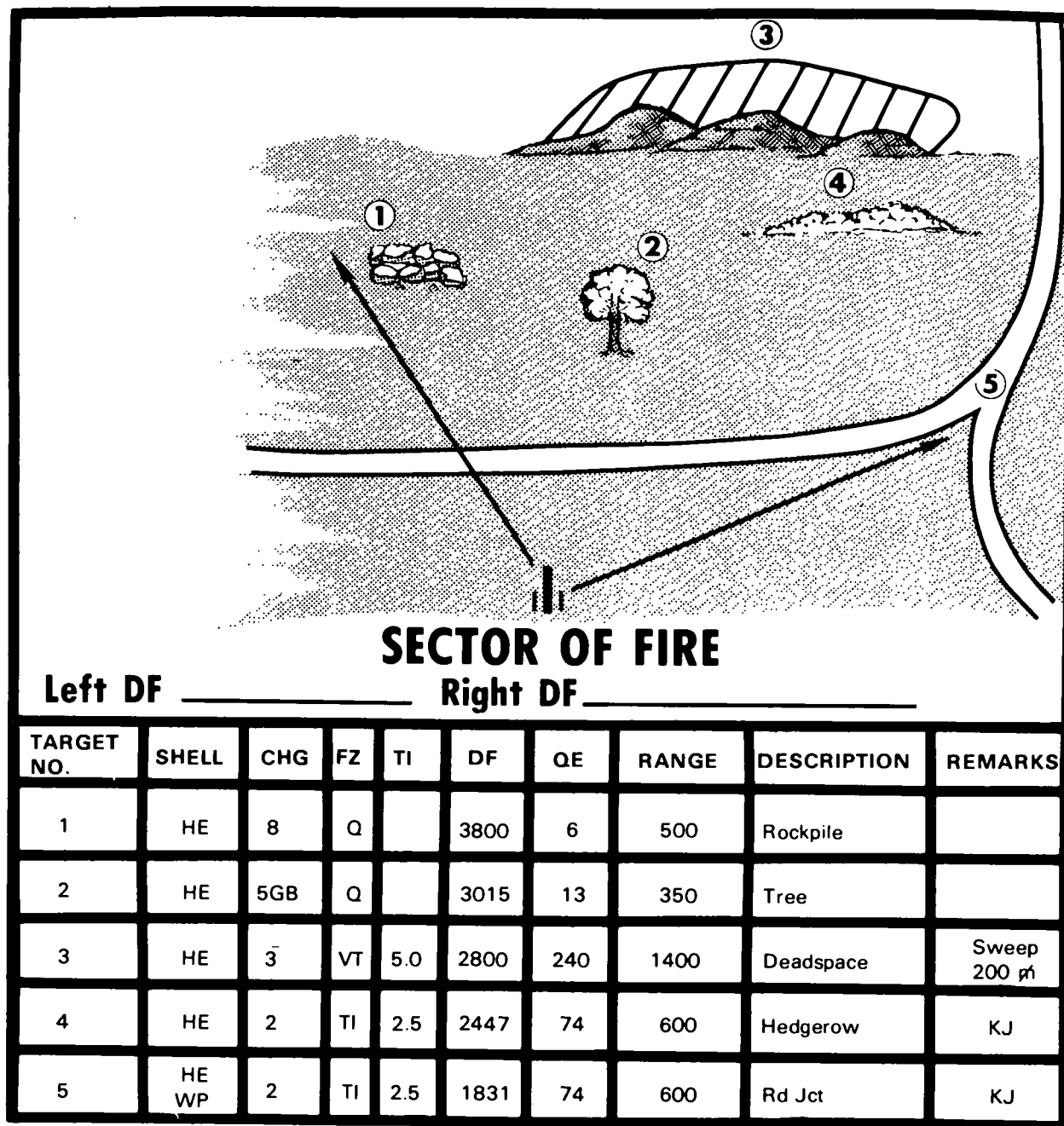
c. Plotting on the diagram. Use a 1:50,000 coordinate scale to plot coordinates and to measure distance on the 1:50,000-scale grid sheet by dividing the indicated graduations on the coordinate scale by 10; e.g., the 1,000-meter graduation is read as 100 meters. Use the protractor for measuring azimuths or direction.

(1) Using the coordinate scale, plot the battery center on the 1:50,000-scale grid sheet. Construct a light line indicating the azimuth of fire. Next, draw a light line perpendicular to the azimuth of fire. Insure that this line crosses battery center. These two lines are used for orientation in direction; i.e., right, left, forward, and rear of the battery center. (Once you have completed the diagram, you may erase these lines.)

(2) Plot the weapon locations and sectors of fire. The following sources are available to assist in this task:

(a) Machinegun range cards indicate the location (distance and direction from battery center or other known point) and the azimuths of the left and right limits and/or final protective line (FPL). The range card is prepared for all crew-served weapons. It is a record of firing data necessary to engage preselected targets within the sectors of fire during periods of limited visibility. The range card may also be used as a reference to engage targets and to aid in the preparation of the defense diagram. Details on preparing machinegun range cards are in FM 23-67, *Machinegun 7.62-mm, M60*.

(b) Cannon range cards indicate deflections of the left and right limits. In addition, they should show key terrain features and predesignated targets with firing data. The range card should consist of two parts—a sketch of the sector(s) of fire containing targets and reference points and a data section that lists data necessary for engaging targets during periods of limited visibility. The format shown in figure 7-8 is recommended for the range card.



Note. To determine the left and right deflection limits and the deflection to key features or targets on the howitzer range card, follow these steps.

1. Set the azimuth scale to 3200.
2. Traverse until the line of sight of the panel is on the point selected.
3. Turn the azimuth knob until a correct sight picture is obtained on the collimator/aiming posts.
4. Record the deflection now shown on the reset counter scale (M100-series sight), or the azimuth scale (M12-series sight) as appropriate.

Figure 7-8. Howitzer range card (155-mm SP section).

(c) Locations of howitzers with respect to battery center must be computed by the FDC, based on deflections and distances from the aiming circle. Other weapons, mines, obstacles, OPs, LPs, and other key installations are located by direction and distance from a known point; e.g., battery center, a howitzer, or a terrain feature.

(3) In all cases, plot locations within 10 meters and directions within 10 mils. On the diagram, indicate the actual location of a weapon by the base of the stem of the weapon symbol. See FM 21-30, *Military Symbols*, for symbols.

7-17. Defense SOP

A battery is extremely vulnerable to enemy action as it first enters a new position. Elements of the battery may still be on the road, and the defense plan for the position may not yet have been implemented. Each battery must prepare an SOP that tells each section its area of responsibility around the battery until the defense plan is implemented. The SOP and the defense plan *must* cover the following areas:

a. Priority of tasks for position area improvement (based on whether the battery commander anticipates remaining during hostile indirect fire or conducting an emergency displacement).

b. Establishment of the FSL and provision for the emergency destruction and evacuation of nuclear weapons.

c. Designation of sound and visual signals to be used for emergency alarms of hazard or attack and the all clear (see STANAG 2047, appendix H).

d. Plans for the emergency destruction of battery equipment, if necessary and feasible. (See STANAG 2113, appendix H.)

e. An easily identifiable rally point far enough from the battery position to escape counterfire directed against the battery and provisions for guides to remain at the rally point to pick up soldiers who become separated from the battery.

f. Provisions for each machinegun, air defense weapon, and antitank weapon to be supported by rifle fire.

g. The method of establishing primary and alternate communications means with all OPs/LPs and the FSL.

h. Scheduled reports to be made by personnel at all OPs and LPs.

i. Establishment and rehearsal of crater analysis teams (see STANAG 2008, appendix H).

j. At dawn and at dusk, conduct of local security patrols of the terrain immediately surrounding the battery, with particular attention to the main supply route and avenues of approach to the position area.

k. A standardized resupply plan for small arms and ammunition, grenades, demolition materials, and pyrotechnic devices.

l. Rehearsal of NBC attack detection and alarm procedures and signals.

m. At night or under limited visibility, particular attention should be paid to the following:

- (1) Use of signs and countersigns.
- (2) Noise discipline.
- (3) Limited movement within the battery.
- (4) Light discipline.
- (5) Employment of available night observation devices.
- (6) Use of illumination if required.
- (7) Restriction of entrance and exit points on the perimeter.
- (8) Use of early warning devices (trip flares).

7-18. The Field Storage Location

In nuclear-capable units, there is a requirement to establish a field storage location for the battery's prescribed nuclear load. The FSL is simply the area surrounding nuclear weapons. Since the PNL normally is kept uploaded on its transportation, the FSL is the vehicle carrying the weapons. The following considerations pertaining to the FSL should be applied during training and included in the unit SOP.

a. Two-man control of the PNL is maintained by two personnel reliability program (PRP) qualified and trained guards. Generally, they are placed at the rear of the vehicle containing the PNL and control access to the nuclear weapons. Each unit SOP describes in detail the setup of the FSL, prescribes the duties of the guards, and outlines the duties of the remainder of the battery with respect to complying with the two-man controlled access requirements of the FSL. Additionally, the SOP tells how assistance to the FSL guards will be provided in the event of an intruder, a fire, or other types of activity that would jeopardize the PNL.

b. The FSL is located within the battery area to provide it as much protection as possible. Its defense must be integrated into that of the battery as a whole. The FSL should be well sited and camouflaged to prevent detection. Additionally, care must be taken to insure the FSL does not present a unique signature, such as using engineer tape to mark its limits or clusters of guards around the load carrier.

c. Communications are established between the FSL and the BOC or FDC.

d. There is a plan to evacuate the PNL if the battery area is threatened.

e. There is a plan for emergency destruction (ED) when:

(1) Loss of two-man control appears imminent; for example, the battery is about to be overrun, and the PNL cannot be evacuated.

(2) A valid order for emergency destruction is received.

f. The unit SOP specifies procedures for emergency destruction of the PNL. The unit's normal ED capability must be sufficient to insure emergency destruction of all nuclear weapons. The SOP will specify:

(1) The amount of ED material to be on hand at all times.

(2) How and where ED material is carried during movement.

(3) How and where ED material is stored with reference to the unit FSL.

(4) Who in the unit is authorized to order emergency destruction and how the order is to be disseminated.

(5) Which unit personnel execute emergency destruction.

(6) How emergency destruction is coordinated with other emergency operations (e.g., local defense, withdrawal, evacuation, and destruction of other classified or major items of equipment).

g. Emergency destruction will likely take place during a period of great stress and confusion. Commanders must insure that sufficient personnel, trained and designated to execute ED, will be available and will not be so committed to perimeter defense or to some other activity that they cannot disengage to execute ED on order. Additionally, nonviolent disablement should be considered when time does not permit a unit to destroy weapons in accordance with established ED procedures. Unit SOP will provide for nonviolent disablement in accordance with appropriate directives.

h. See FM 100-50, *Nuclear Unit Operations in Combat*, for more discussion of the FSL and nuclear operations.

Section III. CONDUCT OF THE DEFENSE

7-19. Defense Against Mounted Attack

a. Enemy motorized forces operate with vehicle hatches open during reconnaissance. During the attack, hatches will be left open until the enemy is forced to button up. Enemy combat units that have infiltrated or broken

through the main battle area (MBA) will look for everything that moves, or has a signature. They may also search likely artillery positions by physical reconnaissance or reconnaissance by fire. If an enemy armor/mechanized force detects the battery, it will take the following actions:

(1) Tanks will continue assault in an attempt to breach or overrun the firing battery positions.

(2) BMPs will maneuver to good standoff fighting positions to fire Saggers (ATGM), 73-mm guns, and machineguns.

(3) This will be followed by a hasty mounted attack through the battery area. If infantry is forced to dismount, they will be accompanied by tanks.

b. The preferred defense against a mechanized ground attack is for the battery to move to a position from which it can continue the fire support mission (alternate position) without a direct confrontation with the enemy force. In some circumstances, however, fighting an enemy mechanized force may be unavoidable. Even though such forces are superior to a field artillery battery indirect firepower, some combat-proven rules for fighting mechanized forces are:

(1) Separate the infantry from the tanks.

(2) Make tanks button up by using artillery, machineguns, or mortars. Use smoke to obscure the enemy's vision.

(3) Cause the tanks to deploy early by making them think they have found a larger force.

(4) Canalize tanks into predetermined kill zones by using obstacles and fire support means.

(5) Use antitank teams (light antitank weapons).

Note. See FM 6-20.

c. Some keys to survival against armor forces are:

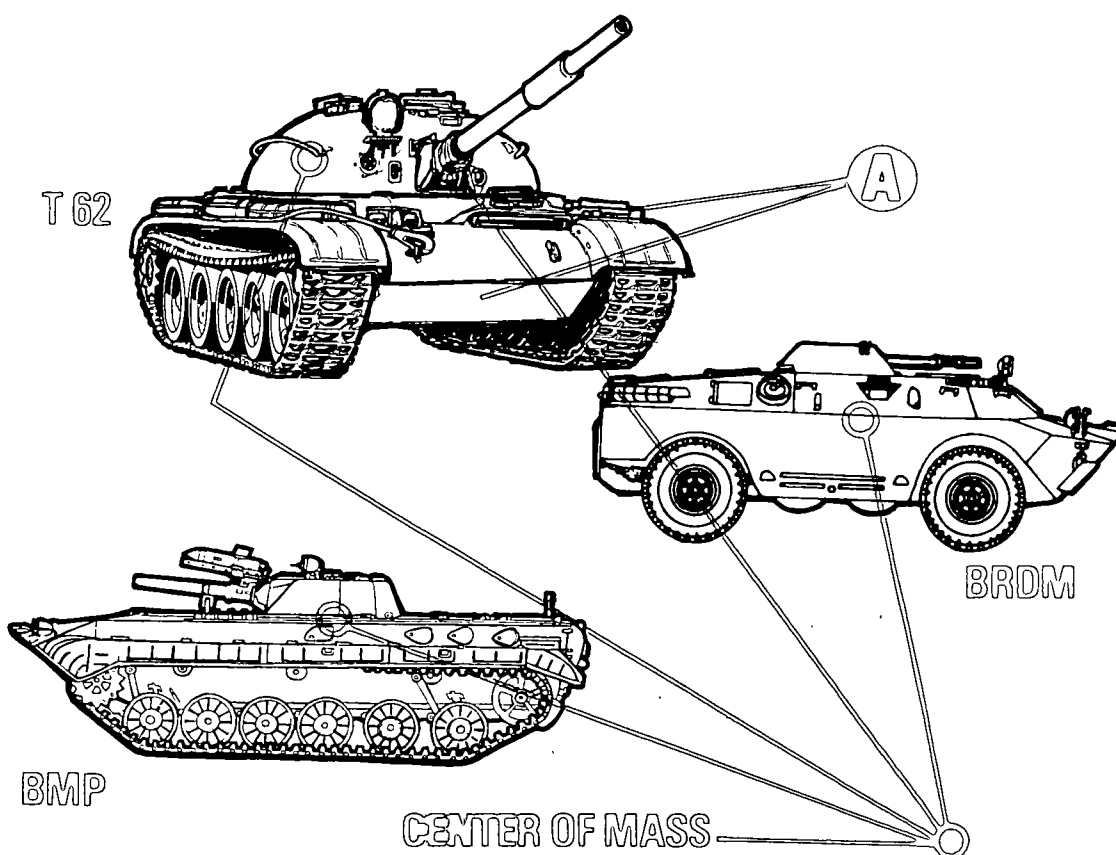
(1) *Early warning.* Insure coordination is accomplished with maneuver elements, clearly define avenues of approach for armored vehicles, and place OPs and LPs to increase the time in which to react.

(2) *Selection of antiarmor positions.* Select fighting positions that will force tanks to button up early. Select antitank positions that will allow firing at the tank's flank, top, or rear; shoot BMPs from front, top, or rear. (See figure 7-9.) Select positions that permit engagement at the maximum effective range

of antitank and crew-served weapons and that have good routes of withdrawal.

(3) *Use of indirect fires as soon as feasible.* Have a defensive fire plan ready. Use smoke to reduce visibility and add confusion or to cover withdrawal. Include DPICM and HE/TI and HE/VT in fire plans.

Usually, the tank has its heaviest armor on the front slopes (A). By comparison, the top, rear, sides, and bottom have much less armor protection. Gunners should try to engage a tank from the side or top whenever possible. The side offers the largest possible target area and less armor protection. When the tank is buttoned up, the visibility of the crew is restricted, thus providing an opportunity for an armor-killer team to approach the tank without being detected.



Always try to get a center-of-mass hit. Hitting an armored target with one LAW rocket probably will not destroy it. Therefore, it is necessary to hit the target with several LAWs to make sure that it is destroyed.

Figure 7-9. LAW aiming points.

d. When field artillery is used in a direct fire role against armored vehicles, proper positioning and tactical employment will improve engagement effects and prolong the survivability of the field artillery battery.

(1) Occupy supplementary antiarmor positions and fire maximum charge with HE/Q or HEP M327 (105-mm only).

(2) Use a minimum of two howitzers to provide mutual support and increase the probability of hit.

(3) Attack with flanking fires as close as possible within effective range of the howitzer. Use the center of mass as the aiming point.

(4) After firing cannons in direct fire, displace to a series of successive supplementary firing positions to engage in more direct fire.

(5) Develop SOP for sequential firing by platoons (e.g., No. 1 fires, then No. 2 gets correction from No. 1 and fires) or mass fires (both No. 1 and No. 2).

(6) Insure howitzer range cards (fig 7-8) are prepared by each section for its primary zone of fire. The battery SOP should direct the type of platoon fire to be used. Prepare and record QE and charge for platoon fire.

7-20. Defense Against Dismounted Attack

a. Dismounted enemy elements, to include armed partisans, will be armed with company, platoon, and squad weapons. These elements will attack by using—

(1) ambushes,

(2) guerrilla-type attacks (normally not exceeding platoon size and often conducted at night or in adverse weather),

(3) a diversionary attack and then a main attack, and

(4) dismounted infantry tactics.

b. While dismounted forces lack the speed and shock action of armor, they do have a significant capability. For example, two or three well-placed snipers can kill key battery personnel and disrupt operations. A properly equipped 10-man combat patrol can effectively neutralize a cannon battery that is lax in its defense planning or execution. To keep this from happening:

(1) Fight the enemy outside the battery position. Engage with cannons, crew-served weapons, and small arms.

(2) Site fighting positions to provide interlocking sectors of fire around the position.

(3) Use an overwatch technique—one element covers the movement of another if defense personnel must withdraw to alternate positions.

(4) Develop a defensive fire plan and coordinate it with the battalion commander, S3, and maneuver units. Especially emphasize the maneuver coordination and insure all fires are coordinated properly.

(5) Establish a battery reaction force to eject forces that have penetrated the battery area or to reinforce weak parts of the battery position. Additionally, establish a rally point inside the battery perimeter at which to rapidly form, organize, and brief the reaction force and identify its location to each member of the reaction force.

(6) Chase the enemy with artillery fires when he is beaten back. Do not dispatch forces to chase him.

(7) Use mines, barbed wire, and other obstacles as approved.

(8) Indicate Killer Junior or Beehive (105-mm only) on range cards. Killer Junior is an HE projectile with minimum time set on the fuze. Both are especially effective against dismounted troops.

c. Again, the best defense against a ground attack (mounted or dismounted) is for the battery to displace to an alternate position. When displacement is not possible, however, the aforementioned "helpful hints" will do much to minimize degradation of fire support and contribute to battery survival.

7-21. Defense Against Air Attack

a. The primary means for a field artillery battery to survive when the enemy has air parity or superiority is to be so well concealed that an enemy pilot cannot detect the battery as a target. If the battery is detected and attacked, the key to survival is a large volume of fire. Immediate actions against air attack are as follows:

(1) The warning signal for an air attack is given as per the unit SOP (see STANAG 2047, appendix H).

(2) Every soldier takes cover and prepares to return fire.

(3) All weapons in the battery are used to return fire. Accuracy is not as important as mass. (See figure 7-10.)

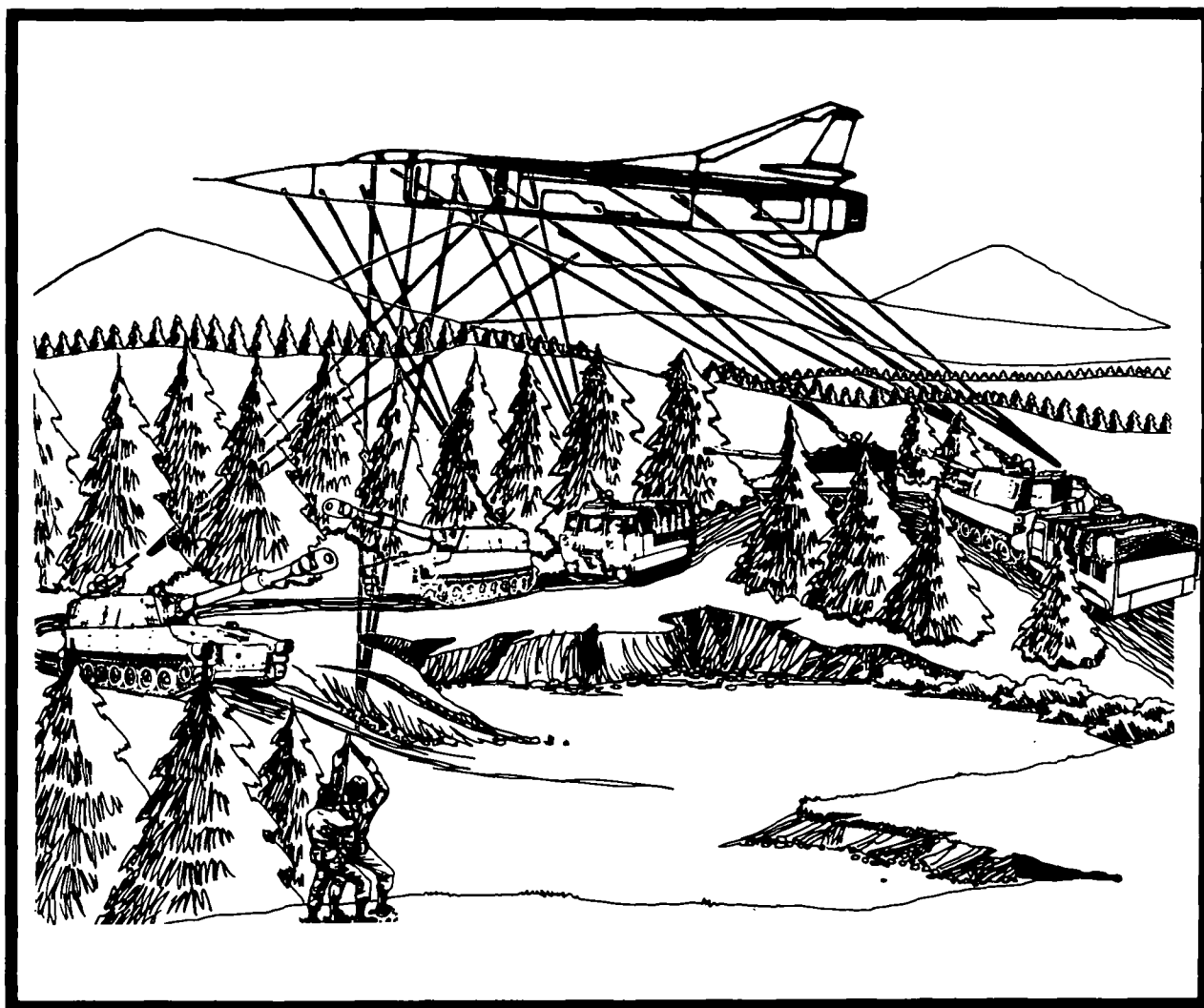


Figure 7-10. Mass battery fires against an air attack.

(4) Ring-mounted machineguns (.50 caliber) are the only organic air defense weapons in the battery. Primary or supplementary positions selected by the battery commander should be occupied by vehicles with ring-mounted weapons (M548 cargo carrier) to return fire.

(5) Stinger/Redeye teams engage enemy aircraft. These teams should be positioned to cover primary low flight avenues of approach into the battery area. Their sector of fire must include the airspace over the battery.

b. Air defense for convoys is as follows:

(1) If possible, move the battery at night, on concealed routes, or during periods of reduced visibility.

(2) Consider infiltration if there is a significant air threat.

(3) Post air guards for each vehicle, and assign sectors of responsibility that permit massing small-arms fires.

(4) Split the Stinger/Redeye team so that the team chief rides near the front of the convoy and the gunner rides at the rear. This facilitates defense in all directions. (See figure 7-11.)

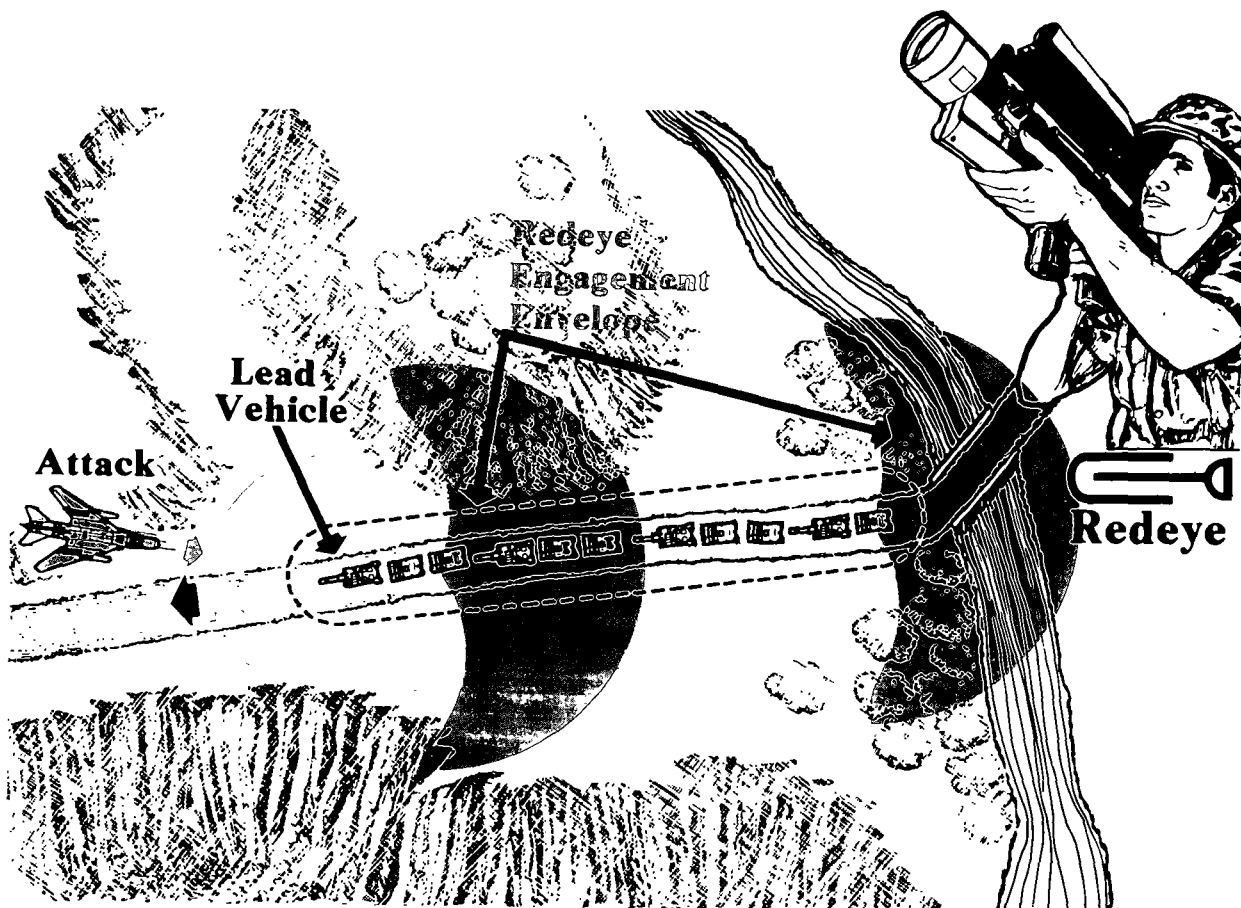


Figure 7-11. Redeye coverage during convoy.

(5) Immediate action against air attack is to stop and disperse vehicles. Everyone must return fire.

7-22. Defense Against Artillery Attack—Immediate Actions

a. The threat of receiving indirect fire is at least as great as the threat of air or ground attack. Enemy forces plan to attack our artillery with great volumes of ammunition. When receiving counterfire, batteries can remain in position and continue the mission or displace immediately to an alternate position away from the danger area, depending on the guidance received from the battalion commander. Firing batteries must be capable of both. The mission may sometimes necessitate continuing the mission regardless of the incoming fire. Predetermined tasks and priorities established for the battery increase survivability. The battery commander establishes the priorities of tasks for improving the position area and insuring that the battery is able to react to indirect fires. Key considerations include the following:

(1) *Commander's guidance.* ("We're going to have to stay in this position if we take incoming.")

(2) *Mission.* ("Our battalion is DS to 3d Brigade. We have to give them support as soon as possible.")

(3) *Enemy situation.* ("There is a lot of counterfire in this zone, so dig in.")

(4) *Terrain and time available.* ("We have about 2 hours before H-hour.")

b. The key to countering the hostile indirect fire threat is effective training for survival. Every means available to reduce vulnerability and increase survivability must be fully explored and used. Cannoneers must understand, as second nature, the immediate actions they are required to perform when fired upon.

c. Upon reaching its firing position, each battery accomplishes a number of minimum tasks. These tasks have been grouped under the memory aid TLASBAPP:

T — Trails, spade, or firing platform emplacement

L — Lay the weapon

A — Aiming points

S — Site to crest

B — Boresight

A — Azimuth markers

P — Prefire checks

P — Position area improvement

This format provides common goals for actions and reactions among battery personnel—specifically, section chiefs and cannoneers. Other tasks representing the last P—position area improvement—are completed as time permits in an effort to continually harden the position. Just as there are priorities in preparing the weapons to fire, there must be priorities for improving the position area to insure the battery is best able to react to indirect fire.

d. Tasks such as camouflage, digging in, and alternate position preparation must be given priorities by the battery commander. He must consider all factors, to include the mission, his commander's guidance (stay or displace), and the enemy situation. The assignment of priorities by the battery commander provides guidance to the section chiefs, who, in turn, establish priorities for the cannoneers in their sections.

e. Whether a battery anticipates rapid emergency displacement or expects to remain in position when "hit" by incoming fire, it still must accomplish the full range of position area improvement tasks. The key difference is determining which to do first.

(1) A battery required to continue the mission under indirect fire will harden its position before it improves an alternate position.

(2) A battery given permission to displace upon receipt of indirect fire places its priority of effort on preparing alternate positions, designating displacement routes, and establishing a signal to march order before it devotes time to hardening tasks.

f. The commander instructed to continue his mission in the position despite hostile counterfire might establish the following tasks in the priority indicated.

(1) Prior to receiving incoming fire:

- (a) Camouflage position area.
- (b) Harden critical items of equipment.
- (c) Prepare individual foxholes.
- (d) Prepare defensive positions.

(e) Select alternate position(s), displacement route(s), and a signal should movement be unavoidable. Brief key personnel.

(2) After counterfire is received:

(a) Personnel take cover and mask/vest as necessary.

(b) Send SITREP to battalion.

(c) Recover unsecured/unprotected items.

(d) Conduct crater analysis and submit SHELREP in accordance with DA Form 2185-R (fig 7-12) and STANAG 2113 (app H).

g. On the basis of the commander's priorities, section chiefs, in turn, designate their priorities. There are many techniques a section chief could use to assist him in his effort. One method might be to make a simple matrix that outlines the duties of crewmembers during an attack (table 7-2).

h. As mentioned earlier, the unit's mission governs the priority of tasks. The battery commander told to displace upon receiving fire has a different list in mind. Examples are as follows.

(1) Prior to receiving incoming fire:

(a) Camouflage position area.

(b) Prepare limited protection for personnel/equipment.

(c) Recon/select alternate position(s), displacement route(s), and march order signal.

(d) Prepare alternate position(s).

(e) Prepare defensive positions.

(f) Improve individual protection.

(g) Improve equipment protection.

For use of this form, see FM 6-121 The proponent agency is the US Army Training and Doctrine Command										
RECEIVED BY		FROM				TIME		NUMBER		
SECTION I - BOMBREP, SHELREP OR MORTREP (Cross out items not applicable.)										
UNIT OF ORIGIN (Current call sign address group or code name)	POSITION OF OBSERVER (Encode if Hq or important OP or Sec F gives info on location)	DIRECTION (Grid bearing of FLASH, SOUND or GROOVE of SHELL (state which) in mils unless otherwise stated) (Omit for aircraft)	TIME FROM	TIME TO	AREA BOMBED SHELLED OR MORTARED (Grid ref. -in Clear) or (Grid bearing to impact in mils and dis from observer in meters-- ENCODED) (Dimensions of the area in meters) by (the radius) or (length and width)	NO. AND NATURE OF GUNS (Mortars, rocket launchers, aircraft or other methods of delivery)	NATURE OF FIRE (Adjustment, fire for effect, harassing ETC.) (May be omitted for aircraft)	NO., TYPE, AND CAL. (State whether measured or assumed) of SHELLS ROCKETS (or MISSILES) BOMBS ETC.)	TIME TO FLASH TO BANG (Omit for aircraft)	DAMAGE (Encode if required)
A	B	C	D	E	F	G	H	I	J	K
SECTION II - LOCATION REPORT							SECTION III COUNTERFIRE ACTION			
REMARKS	SERIAL NUMBER (Each location which is produced by a locating unit is given a serial number)	TARGET NUMBER (If the weapon/ activity has previously been given a target number it will be entered here)	POSITION OF TARGET (The grid reference or grid bearing and distance of the located weapon/ activity)	ACCURACY (The accuracy to which the weapon/ activity was located. CEP in meters and the means of location if possible)	TIME OF LOCATION (The actual time the location was made)	TARGET DESCRIPTION (Dimensions if possible): 1. radius of target in meters 2. target length and width in meters.	TIME FIRED (Against hostile target)	FIRED BY	NUMBER OF ROUNDS - TYPE OF FUZE AND PROJECTILES	
L	M	N	P	O	R	S	T	U	V	

DA FORM 2185-R, 1 May 78 (Conforms with STANAG NO. 2008) Edition of 1 Nov 67, is obsolete.

Figure 7-12. Artillery Counterfire Information Form.

- (2) After counterfire is received:
- (a) Signal march order (emergency displacement).
 - (b) Displace to alternate position.
 - (c) Report displacement.

(d) Continue mission from alternate position.

i. The section chief's subsequent priorities are illustrated in table 7-3.

Table 7-2. Example of Duty Assignment Matrix (Unit to Maintain Present Position)

Section Chief	Gunner	Assistant Gunner	Section Members	Driver
1. Prepare range card.	Sandbag the collimator.	Install camouflage net.	Harden critical items of equipment with sandbags (M458, all tires, etc.)	Bury the wire.
2. Brief personnel on displacement route(s), alternate position, and signals to be used.	Assist with camouflage.	Continue to improve camouflage, i.e., use natural vegetation.	Prepare individual and defensive positions.	Become familiar with displacement route(s) and alternate position.
3. Supervise at supplementary position, assign members to crater analysis team.	Continue to improve camouflage.	Prepare supplementary position.	Selected members prepare supplementary positions.	Assist at supplementary position.
4. Take cover, mask/vest, and man defensive positions as necessary.				
5. Continue the mission.				

Table 7-3. Example Duty Assignment Matrix (Unit Allowed to Displace)

Section Chief	Gunner	Assistant Gunner	Section Members	Driver
1. Prepare range card.	Sandbag collimator.	Install camouflage net and improve with vegetation.	Assist with camouflage.	Prepare vehicle for quick evacuation.
2. Brief personnel on displacement route(s), alternate position, and signals to be used.	Supervise preparation of alternate position.	Continue improvement of camouflage.	Selected members continue camouflage. Selected members prepare alternate positions.	Become familiar with displacement route(s) and alternate position. Assist at alternate position.
3. Supervise preparation of individual and defensive positions.	Supervise improvement of equipment protection.	Assist at individual and defensive positions.	Selected members prepare individual and defensive positions. Selected members improve equipment protection.	Assist with equipment protection.
4. Take cover, mask/vest as necessary.				
5. Continue mission while awaiting signal to displace.				
6. Displace as per prior instructions.				

7-23. Defense Against Nuclear or Chemical Attack

For discussion of defensive measures to be taken against nuclear or chemical attack, see FM 21-40 and FM 21-41, *Individual Defense: Nuclear, Biological, Chemical*. Refer to STANAG 2047 (app H) before developing standard warning signals for chemical or nuclear attack.

7-24. Convoy Defense

a. In general, the fundamental considerations for convoy defense are the same as those for position defense. For example:

(1) Maintain some form of a perimeter as you evacuate the old position and establish one as you occupy the new position. Sweep a new position, either with M548 or on foot, before entering it.

(2) Establish SOPs for convoy operations. Make sure all personnel know the signals and immediate actions. Rehearse these techniques often.

b. Convoy organizations may vary depending on the tactical situation, but there are some basic principles to follow:

(1) Maintain communications throughout the convoy—as a minimum, between the front and the rear of the column.

(2) Use air guards and Stinger or Redeye, if available (see figure 7-11).

(3) Distribute crew-served weapons throughout the convoy to provide uniform protection.

(4) In daylight, maintain as much interval as possible in the convoy (100 to 200 meters).

(5) Consider infiltration as a possibility for movement.

(6) Sandbag the driver, crew, and cargo areas of battery vehicles to improve troop survivability against mines. Use the sandbags in the battery position for cover and position hardening after the move is completed.

c. If the convoy encounters an unblocked or blocked ambush, take the following immediate actions.

(1) Immediate actions against an unblocked ambush:

(a) Increase speed and move out of the ambush.

(b) Return fire (e.g., 50 percent M16s on full automatic, 50 percent semiautomatic).

(c) Signal so that following vehicles can speed up and be ready to shoot.

(d) Report ambush location to battalion.

(2) Immediate actions against a blocked ambush:

(a) Dismount.

(b) Attack through the ambush.

(c) Signal so that following vehicles are aware that an ambush is in progress. Personnel not directly involved in the ambush dismount and conduct a flank attack. Do not leave vehicles unguarded. Drivers remain with vehicles according to SOP.

(d) Call for supporting artillery fire.

Section IV. TRAINING TECHNIQUES

7-25. General

Soldiers must know the tactics that bring them together as a team, and they must be able to use their weapons effectively. This confidence and knowledge can be gained only by frequent, realistic, and repetitive training. All of the training tips described are based on

the individual proficiency skills directed in the soldier's manuals for field artillerymen (13B) and the basic combat skills required of all MOSs. These tips are provided as a basis for collective training of a battery or sections to meet Army Training and Evaluation Program (ARTEP) standards.

7-26. Weapons Training

a. Cannons.

(1) Practice direct fire in all field exercises with either dry or live fire or simulations. Require range cards for all sections. Train crews to engage targets by using immediate actions described in unit SOP. During training exercises, displace a howitzer platoon under section chief control to supplementary positions and engage targets using sequential or mass fire techniques. Two training devices useful in developing direct fire proficiency are:

(a) *The artillery direct fire trainer (ADFT).* This device allows section chiefs to effectively train their sections in direct fire techniques without firing live ammunition. The ADFT consists of an adapter kit that fits all 105-mm and 155-mm howitzers, an M55 laser, and a target board for mounting on a 1/4-ton trailer. The device allows engagement of a moving target at ranges of 40 to 160 meters. This means you can train in your motor pool. The laser makes a red spot on the target that the crew can see. If you don't see the spot—you missed, Section chiefs can adjust successive rounds on the target the same way they do for live fire.

(b) *The M31 trainer.* Use the M31 for direct fire training in your local training areas. This is an effective device to develop direct fire skills at low cost.

(2) The aforementioned devices allow commanders to get more value out of live fire training because sections can be proficient in all direct fire techniques before the first full-service round is fired. However, they must place emphasis on camouflage, light and noise discipline, and section response to immediate actions. ARTEPs and soldier's manuals outline required tasks for howitzer sections. This will give a battery a better chance to fight and survive.

(3) Additionally, commanders must insure their soldiers can distinguish between threat and friendly vehicles. Table 7-4 depicts typical threat armored vehicles, while table 7-5 shows friendly armored vehicles.

Table 7-4. Typical Threat Armored Vehicles

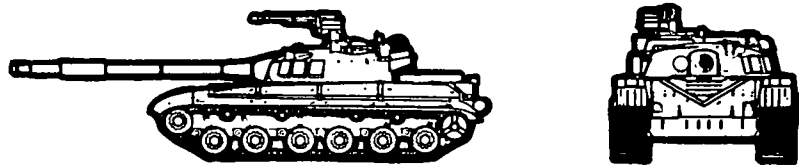
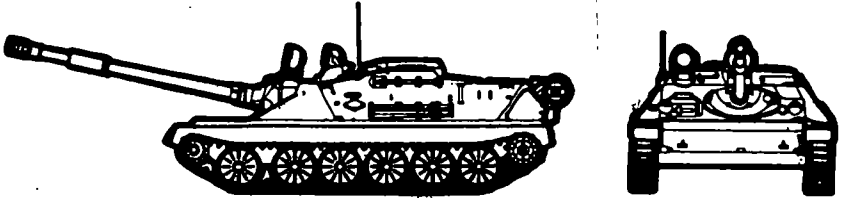
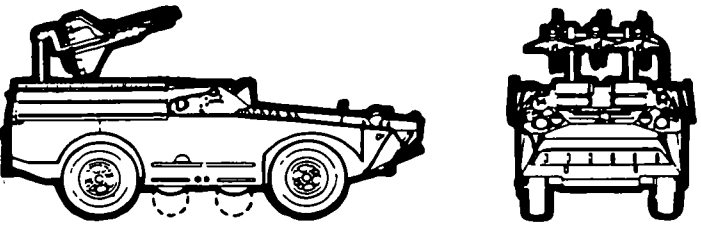
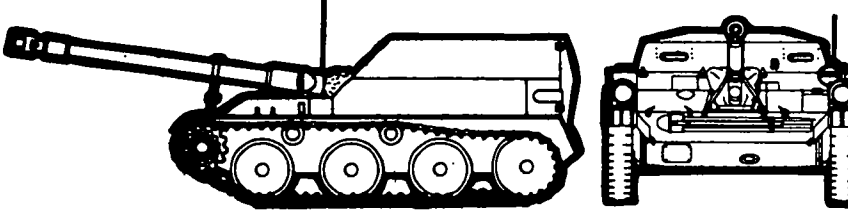
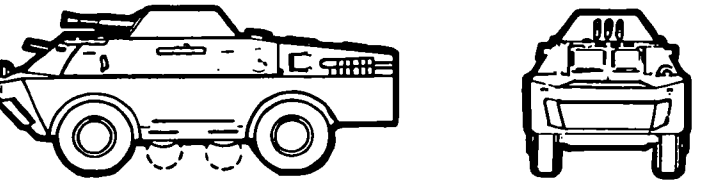
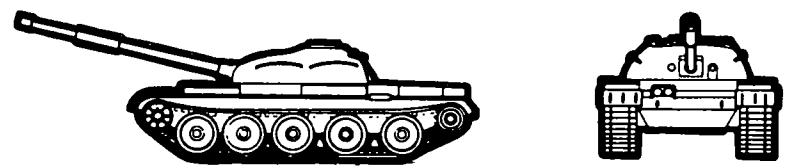
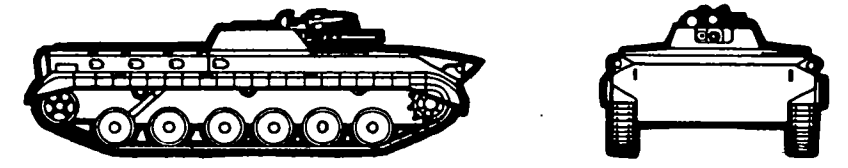
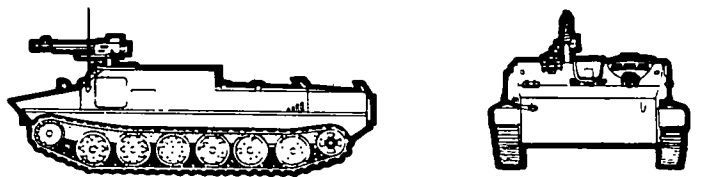
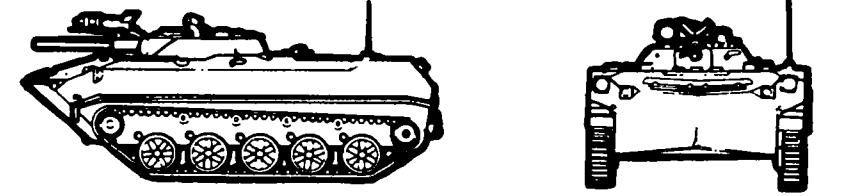
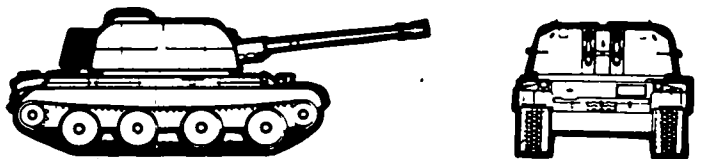
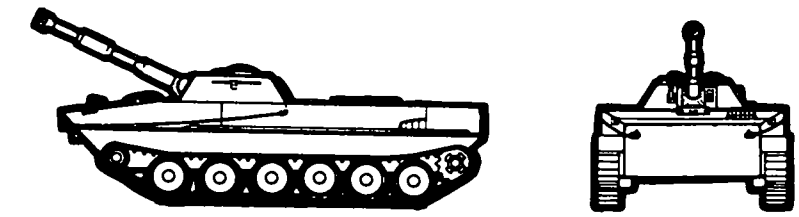
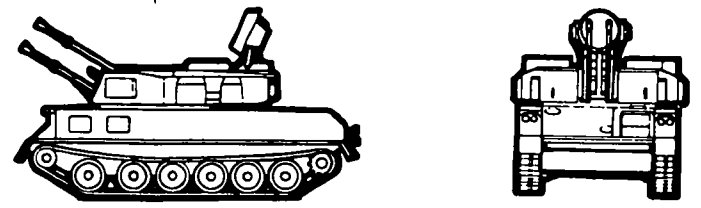
NAME/ARMAMENT	PROFILE	NAME/ARMAMENT	PROFILE	NAME/ARMAMENT	PROFILE
T-72 TANK 125 MM 12.7-MM MG 7.62-MM MG		ASU-85 AIRBORNE ASSAULT GUN 85-MM GUN 7.62-MM MG		BRDM-1 RECON VEHICLE ATGMs or 12.7-MM MG or 7.62-MM MG	
T-64 TANK 125 MM 12.7-MM MG 7.62-MM MG		ASU-57 AIRBORNE ASSAULT GUN 57-MM GUN		BRDM-2 SERIES RECON VEHICLE 14.5-MM MG 7.62-MM MG or ATGMs or SA-9 AIR DEFENSE MISSILES	
T-62 TANK 115-MM GUN 7.62-MM MG		BMP INFANTRY COMBAT VEHICLE 73-MM GUN 7.62-MM MG SAGGER ATGM		BTR-50 SERIES 12.7-MM MG or 7.62-MM MG	
T-54/55 TANK 100-MM GUN 7.62-MM MG		BMD LIGHT TANK FIRE SUPPORT VEHICLE 73-MM GUN 7.62-MM MG		ZSU 57-2 ANTI-AIR- CRAFT GUN 2 EA 57-MM GUNS	
PT-76 AMPHIBIOUS TANK 76.2-MM GUN 7.62-MM MG		BTR-60 SERIES APC BTR-60 PB 14.5-MM MG 7.62-MM MG BTR-60 PK 7.62-MM MG		ZSU 23-4 ANTI-AIRCRAFT GUN 4 EA 23-MM CANNONS	

Table 7-5. Friendly Armored Vehicles

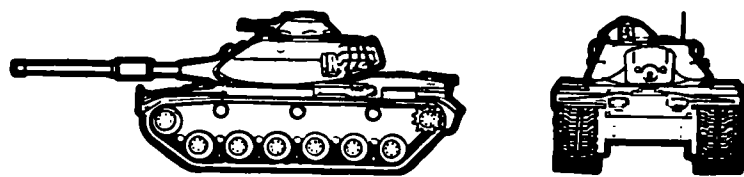
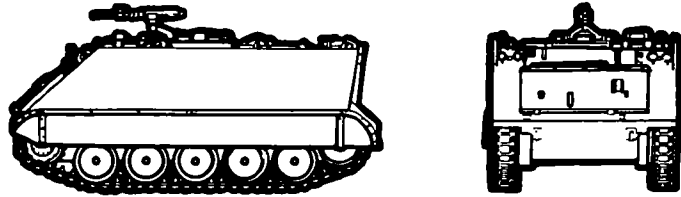
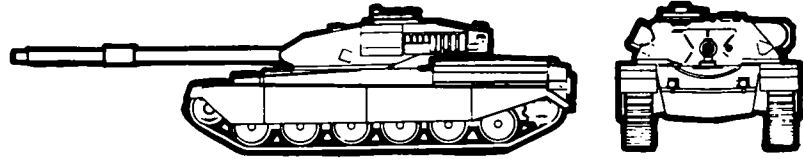
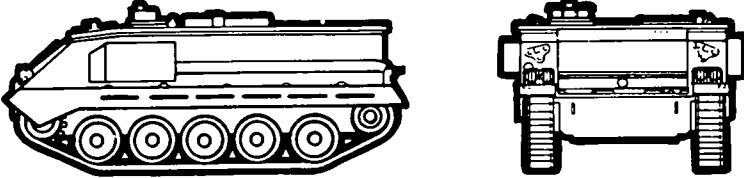
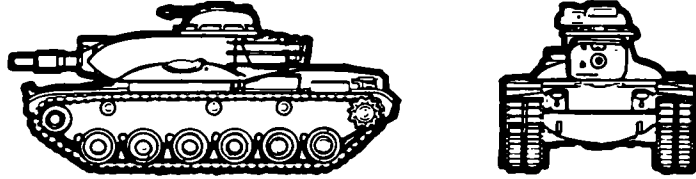
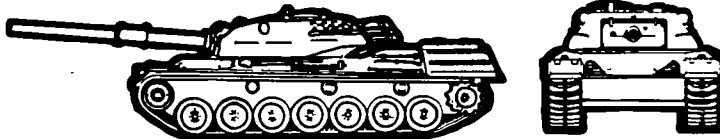
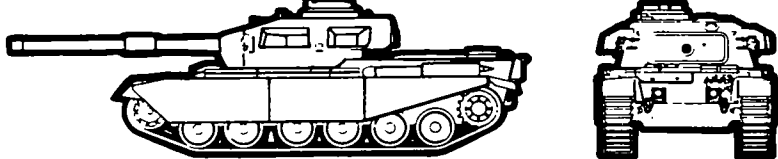
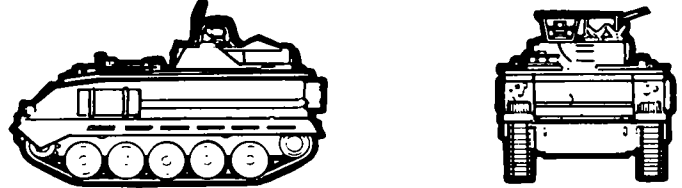
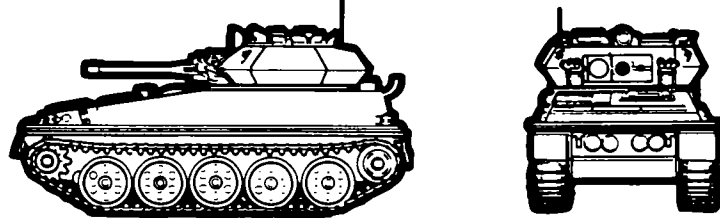
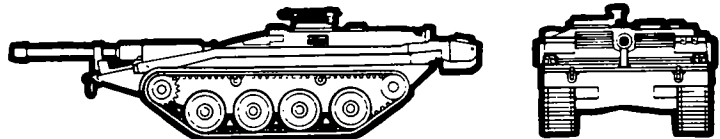
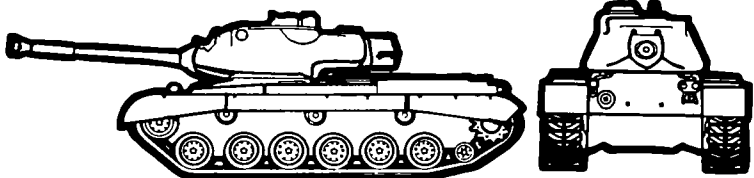
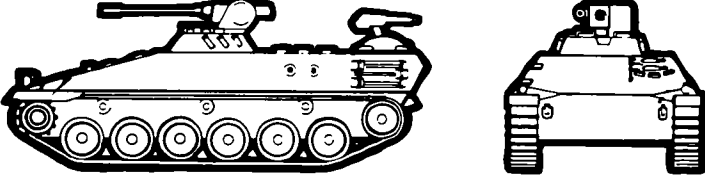
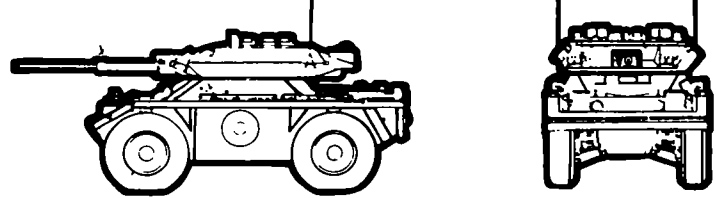
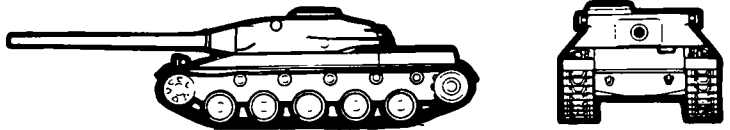
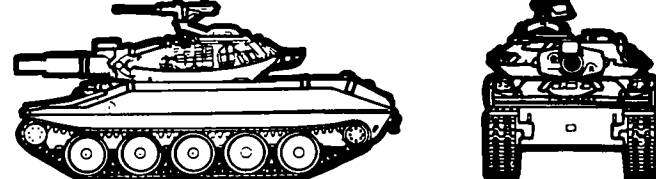
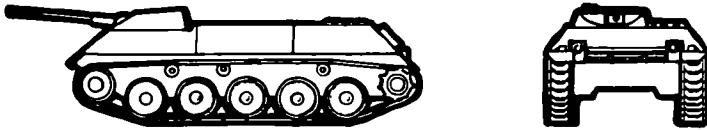
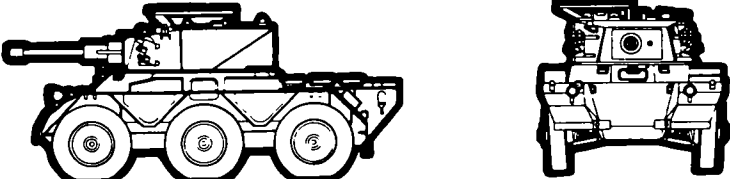
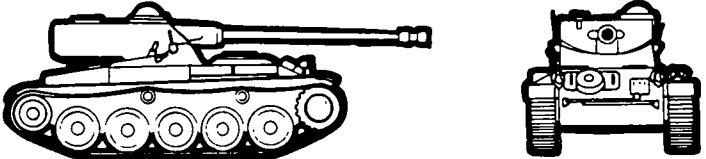
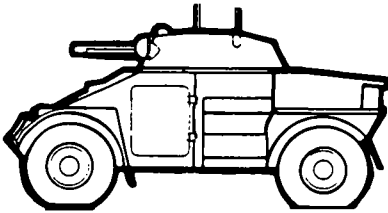
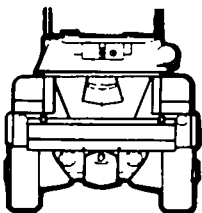
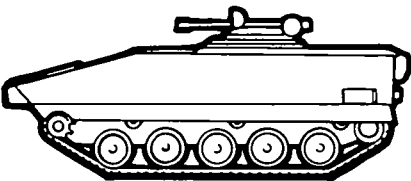
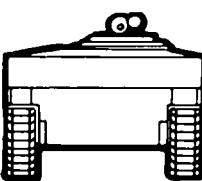
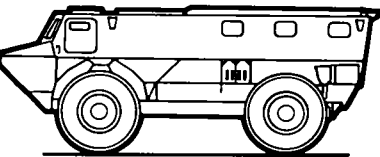
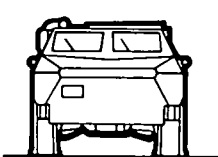
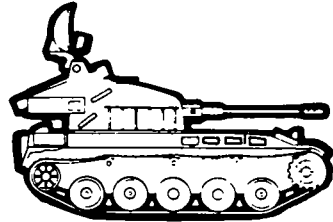
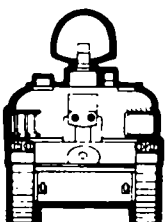
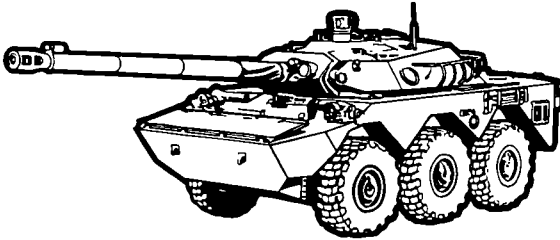
COUNTRY OF ORIGIN/ NAME/ARMAMENT	PROFILE	COUNTRY OF ORIGIN/ NAME/ARMAMENT	PROFILE	COUNTRY OF ORIGIN/ NAME/ARMAMENT	PROFILE	COUNTRY OF ORIGIN/ NAME/ARMAMENT	PROFILE
USA M60A1 TANK 105-MM GUN .50 CAL MG 7.62-MM MG VARIANTS: M60/M60A3		USA M113 SERIES APC .50 CAL MG		GREAT BRITAIN CHIEFTAIN TANK 120-MM GUN 12.7-MM MG 7.62-MM MG		GREAT BRITAIN FV 432 SERIES APC 7.62-MM MG or VARIOUS OTHER WEAPONS	
USA M60A2 TANK 152-MM GUN/MISSILE LAUNCHER .50 CAL MG 7.62-MM MG		WEST GERMANY LEOPARD I SERIES TANK 105-MM GUN 7.62-MM MG		GREAT BRITAIN CENTURION TANK 105-MM GUN 12.7-MM MG 7.62-MM MG		GREAT BRITAIN FV 438 ATGM VEHICLE ATGMs 7.62-MM MG	
USA M48 TANK 90-MM or 105-MM GUN .50 CAL MG 7.62-MM MG VARIANTS: M48A1, A2, A3, A5		WEST GERMANY JPZ 4-5 ANTITANK GUN 90-MM GUN 7.62-MM MG		GREAT BRITAIN FV 101 SCORPION RE- CON VEHICLE 76-MM GUN 7.62-MM MG		SWEDEN STRV 103 "S" TANK 105-MM GUN 7.62-MM MG	
USA M47 TANK 90-MM GUN .50 CAL MG 7.62-MM MG		WEST GERMANY MARDER-INFANTRY COMBAT VEHICLE 20-MM CANNON 7.62-MM MG		GREAT BRITAIN FV 721 FOX RECON VEHICLE 30-MM CANNON 7.62-MM MG		FRANCE AMX 30 TANK 105-MM GUN 12.7-MM MG 7.62-MM MG	
USA M551 RECON VEHICLE 152-MM GUN/MISSILE LAUNCHER .50 CAL MG 7.62-MM MG		WEST GERMANY SPZ 12-3 APC 20-MM CANNON 7.62-MM MG		GREAT BRITAIN FV 601 SERIES SALADIN RECON VEHICLE 76-MM GUN 7.62-MM MG		FRANCE AMX 13 LIGHT TANK 90-MM GUN 7.62-MM MG	

Table 7-5. Friendly Armored Vehicles—continued

COUNTRY OF ORIGIN/ NAME/ARMAMENT	PROFILE	
FRANCE AML SERIES RECON VEHICLE—VARIETY OF TURRET DESIGNS WITH: 60-MM MOR- TARS, MGs or CANNONS		
FRANCE AMX 10 SERIES INFANTRY COMBAT VEHICLES 20-MM CANNON 7.62-MM MG		
FRANCE VAB APC 7.62-MM MG or 20-MM CANNON or VARIOUS OTHER ARMAMENTS		
FRANCE AMX 30 ANTI-AIR- CRAFT GUN TWO 30-MM CANNONS		
FRANCE AMX 10 RC RECON VEHICLE 105-MM CANNON 7.62-MM MG		

b. *M72 LAW (light antitank weapon)*. The battery commander designates individuals who will form two-man antitank teams. All personnel in the battery should be familiar with the LAW from basic training and unit training programs. However, the battery defense requires that LAW teams deploy on a moment's notice to stop an attack—the quality of these teams may impact heavily on battery survival. The LAW gunners selected should be the best qualified men as determined from SQT results and battery training evaluation. The gunners should train and work as teams to recognize, acquire, sight, and attack enemy targets rapidly and accurately and then to displace to alternate positions to attack again.

(1) If live firings are limited, previously fired LAWs become valuable training aids. Organize a vehicle slalom course in the motor pool or in a close-in training area. Issue each LAW gunner an expended but properly packaged LAW. Have the gunners select the best positions for attacking target vehicles (any large vehicle such as a 5-ton truck, an SP howitzer, or a tank). Have the gunners unpack and prepare the LAW for firing. Use a signature-marking device, such as an artillery simulator, to be activated by the gunner when he simulates firing. If personnel on the target vehicle can observe the LAW teams as they move, the LAW teams need more training. The LAW subcaliber device (see FM 23-33, *66-mm HEAT Rocket, M72A1, M72A1E1, and M72*) makes this training even more realistic.

(2) A LAW trainer is currently being added to the inventory and will be available at local training aids offices. It fires an M73, 35-mm practice rocket that has the same ballistic characteristics as the LAW round. This enables the gunner to get realistic experience, since it uses the same sight picture as the M72. The practice rocket has the same backblast, noise, and flash as an M72 LAW. This helps gunners gain confidence in the weapon system. Since the practice rocket produces only a flash, noise, and puff of smoke on impact, training can be made more realistic by actually engaging moving armored vehicles.

(3) Armored vehicle recognition cards (GTA 17-2-8) can be ordered to train gunners in detecting a wide variety of armored vehicles, both threat and friendly.

c. *M16A1 rifle*. All skills required by the soldier's manuals for the M16A1 should be reinforced by active participation in field exercises with blank ammunition and live fire when practicable. The rifleman may also fire at aircraft. Firing at aircraft from the prone position means the firer is lying on his back, aiming his rifle into the air. It won't take the soldier long to learn that he wants to fire from some kind of cover and concealment, no matter how small. If he's in a foxhole, he'll probably fire from a supported standing position. If he's not in a foxhole, he should look for a tree, a large rock, or something to help support the weapon and protect him. (See FM 23-9, *M16A1 Rifle and Rifle Marksmanship*.)

d. *M60 machinegun*. The qualifications for personnel using the M60 should conform to soldier's manual standards. This weapon will be used, along with the .50 caliber machinegun (MG), to button up tanks. It is the primary crew-served weapon for battery personnel. It is lighter and more mobile than the .50 caliber and easier to use. Train the gunners to engage tanks from ambush when in supplementary positions, and have them select positions that provide interlocking fires and mutual support. Use the M60 against aircraft. The M60 gunner should fire from some protected positions if possible. He needs to get the weapon up in the air. He can hold it up or use some support for his arms and the weapon. In a real emergency, another soldier can act as a hasty firing support.

e. *.50 caliber machinegun, M2 (heavy barrel)*. M2 operators should have the skills prescribed in the soldier's manuals. This specifically applies to range card preparation and to the use of the tripod mount. A .50 caliber MG, mounted on an M548, is excellent for reaction forces, especially when distances must be covered quickly to react to any enemy threat. It is a good weapon against armored personnel carriers (APC) and dismounted infantry. Gunners must know all the ways to employ the weapon and the importance of proper headspace and timing to insure the

weapon will be operational when needed. Use TEC lessons; TC 44-30, *Aircraft Recognition Training for Ground Observers*; and enemy aircraft flashcards to teach battery personnel hostile aircraft identification. An M548 with a mounted M2 can be used to button up tanks when in a supplementary position. (See FM 23-65, *Browning Machinegun, Caliber .50 HB, M2*, for further references.) The ARTEPs designate the tasks, conditions, and standards for defense against ground and air attacks.

f. M203 grenade launcher. This weapon can cause armored vehicles to button up hatches. It provides smoke and is highly effective against dismounted troops. The M203 can fill gaps in the defense as the battle develops and can provide considerable firepower when employed in pairs. Its use should be practiced in training.

7-27. Nuclear Mission Training

The battery commander must train his unit to perform its nuclear mission. He must train sufficient personnel to perform all the functions involved in the nuclear mission from tactical convoys to technical operations

to emergency destruction. A prime consideration in selecting personnel to be trained is the requirement for depth. In other words, there must be enough people trained so that if a number of key individuals are lost, there will be someone to take their places without jeopardizing the mission. The battery commander must understand that the unit's nuclear mission is a battery mission, not the job of a select few supertroops.

7-28. Obstacles

Train the battery to use natural terrain to its advantage and to use mines and demolitions to create obstacles to provide the unit more defensive capability. Battery noncommissioned officers must train their personnel to assist them in emplacing and recovering mines and in creating obstacles such as abatis, ditches, or stumps and posts. A training method is to use terrain walks and look at various avenues of approach from both the friendly and enemy sides. This will familiarize the troops with the techniques for planning and locating obstacles. (See FM 5-15 and FM 20-32, *Mine/Countermine Operations at the Company Level*.)

Section V. Summary

7-29. Defense—A Review

a. Personnel in the "lean and mean" firing battery must be well trained in how to defend their battery. Planning, early warning, and close cooperation and coordination among all members of the combined arms team are key to defending, winning, and surviving.

b. Timely movement is one key to survival. However, if the battery has not been given enough time through early warning to react and move, movement may result in disaster. Good communications from battery OPs and LPs, along with good training and planning, allow the battery to displace before it is attacked. Sometimes the battery cannot move because the maneuver force needs fire support, so it must defend if attacked. The battery commander may have to stand and fight when a roving gun is operating. This

means there are fewer men and weapons for defending the main position. A split battery operation means that there are two battery positions to defend. This places heavy demands on coordination, control, communications, and available firepower. The battery commander must consider and plan for the possibility that enemy forces can get between the two elements of a split battery. This is when planned fires from other field artillery units can make the difference between winning and losing. A split battery operation requires detailed, thorough planning and concentrated effort to get maximum security from available personnel. The keys to survival are training, coordination, and early warning. The ground commander owns the real estate, and coordination must be made with him. He may give assistance to the battery defense.

c. The number of people available for defense from howitzer sections and FDCs will vary depending on the type of unit involved (105-mm, 155-mm, 8-in). For example, a 155-mm SP unit may have between five and nine people present for duty in a howitzer section. Using an average of seven men per section, three people are left for defense per section after the critical positions of chief, gunner, assistant gunner, and cannoneer are filled. This leaves a tentative total of 18 men. It takes two additional people per section to drive the M548 and to man the .50 caliber MG, leaving six men. Counting approximately 2 men from the FDC, you have a defense team of 6 to 10 men, from which OPs and LPs must be organized. Post approximately two two-man OPs toward anticipated avenues of approach, and use the remainder of the team nearer the battery in LPs and fighting positions. This organization can provide the battery early warning and limited security near the battery position.

d. When a battery establishes proper security and defenses—

(1) *The threat is detected.* The enemy may be detected by an OP or an LP. In either case, the battery commander must act. He calls the battalion commander or S3 and advises him of the situation.

(2) *The threat is identified.* Determine if the threat is a mech/armor, dismounted, or irregular force so that appropriate, immediate actions can be taken. The LPs and OPs will provide this warning and will report to the battalion CP or to the maneuver element.

e. Depending upon the situation, the battery may displace or it may remain in position.

(1) If cleared to move, the battery commander:

(a) Orders immediate displacement to an alternate position.

(b) Requests the battalion S3 to divert fire support missions to other assets, to select other batteries to fire defensive fires for the battery, and to request attack helicopters or tactical air to deal with the tanks.

(c) Directs some cannons to move to supplementary direct fire positions.

(2) If unable to displace, the battery commander:

(a) May order the OPs to engage the enemy with antitank weapons to force him to deploy and to allow more preparation time for the defense.

(b) Alerts battery personnel to the threat. All soldiers take cover and man fighting positions.

(c) Deploys LAW antitank teams along the avenues of approach into the position.

(d) Moves M548s with mounted .50 caliber MGs to defense positions.

(e) Insures mutually supporting fires are available within the battery and requests additional antitank teams from battalion.

(f) Sends howitzers to supplementary direct fire positions.

(g) Reinforces the perimeter positions as possible.

(3) The battalion commander or S3 may dispatch a defense team to the battery to supplement the defense. These teams should be equipped with LAWs. The team is deployed under the battery commander's direction.

f. The battery can engage the threat or let him bypass.

(1) With the assistance provided by the battalion headquarters and other support elements, the field artillery battery can survive against small to medium (2 to 10 tanks) mechanized or dismounted forces.

(2) Let the threat bypass you if he does not detect your position. Report his movement to battalion at once.

(3) If the enemy detects the battery position and attacks, immediate actions for ground attack must be implemented. Through training and planning, the battery knows the required actions.

(a) LAW teams know that they fire when the tanks enter previously selected kill zones. Following the initial engagement (by team), the antitank teams maneuver to alternate positions to get flanking or rear shots at the tanks.

(b) Cannons move to supplementary direct fire positions in the battery position.

(c) All available organic weapons are used to keep the tanks buttoned up.

(d) At the same time, the battery commander may call for continuous field artillery smoke to reduce the tankers' visibility and disrupt their command and control capability.

g. In summary, the mission of field artillery cannon batteries is not to fight tanks, BMPs, and infantry head on but to provide field artillery fire support to the force. Through early warning, cannon batteries

can displace to avoid becoming engaged. When fire support requirements preclude displacement, the battery must fight. Thorough training, sound planning, and immediate actions will enable the battery to repel limited attacks and to return to its primary mission of providing firepower to the combined arms team.

7-30. Battery Checklist for Defense

Table 7-6 is a checklist to assist units in the conduct of the defense.

Table 6-6. Battery Checklist for Defense

BATTERY CHECKLIST FOR DEFENSE

PLANNING

- I. Select battery position to insure:
 - A. Mission accomplishment.
 - B. Survivability.
- II. Choose terrain that has the greatest potential for defense and survival. Consider:
 - A. Can the battery obtain supporting fires to engage the enemy with long-range fire?
 - B. Does the battery position deny the enemy observation and direct fire into our area?
 - C. Does the position allow establishment of observation posts that:
 - (1) Can see likely avenues of approach?
 - (2) Provide early warning?
 - (3) Can exploit LAW?
 - D. Is the battery integrated into the overall plan for defense of the higher or adjacent units?
 - E. Are there areas where close decisive engagements can be achieved if necessary? (LAW teams and platoons in direct fire require primary, alternate, and supplementary positions.)
- III. Have priorities been given to immediate-action tasks for hostile counterfire?

PREPARATION

- I. Have a defense diagram that shows:
 - A. Prominent terrain features and distances.
 - B. Primary howitzer positions.
 - C. Locations of mines or other barriers.
 - D. Fields of fire (interlocking) for automatic weapons.
 - E. Supplementary positions for howitzers.
 - F. Reaction force assembly positions.
 - G. Assigned direct fire sectors to sections.
 - H. LPs, OPs.

Table 7-6. Battery Checklist for Defense—continued

II. Prepare positions and continuously improve them.

- A. Fighting positions.
- B. Observation posts.
- C. Complete range cards for each position.
- D. Listening posts.
- E. Emplaced obstacles (mines and early warning devices).
- F. Sleeping positions.
- G. Designated supplementary positions.

III. Rehearse cannoneer tasks for immediate actions under hostile counterfire.

HARDENING

I. Continuously improve the position.

- A. Provide overhead cover for all fighting positions.
- B. Position howitzers in defilade with maximum camouflage and cover.
- C. Establish local patrols.
- D. Establish listening posts.
- E. Have all antitank teams prepare primary and alternate positions that cover the decisive engagement area.
- F. Have OPs adjust indirect fire as available on targets of opportunity.
- G. Eliminate six factors of recognition.

II. Coordinate immediate actions.

- A. Rehearse by teams.
- B. Check range cards for each section and each position.
- C. Direct mutually supporting fires to defensive targets.

PART THREE

OPERATIONS



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CHAPTER 8

LAYING THE BATTERY

Section I. THE AIMING CIRCLE

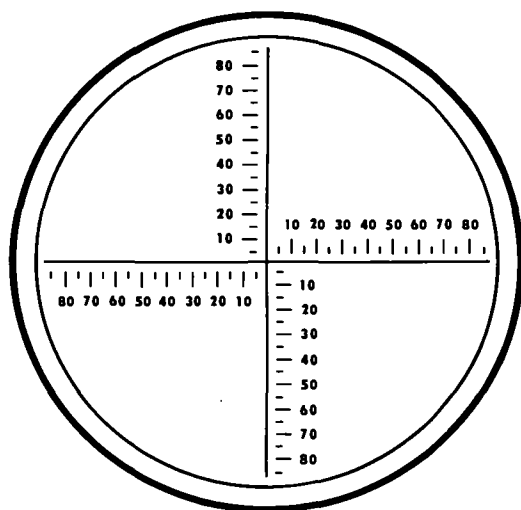
8-1. General

The M2 aiming circle is the cannon battery's primary means of orienting, or laying, its weapons on the azimuth of fire. It is a solid, reliable instrument, but it must be cared for and operated correctly. It is important that each person involved with using the aiming circle be thoroughly familiar with how to operate and maintain it. This chapter presents information that should be the starting point for any aiming circle training program.

8-2. Components

The instrument operator must be thoroughly familiar with the components of the aiming circle. The following is a discussion of the major components.

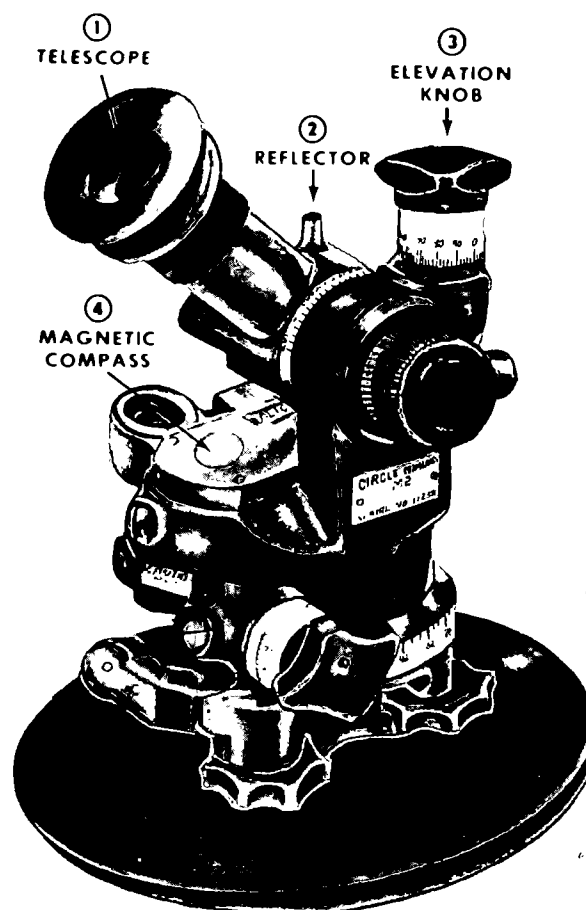
a. Telescope. The telescope (1) is a 4-power, fixed-focus optical instrument with a reticle pattern like this—



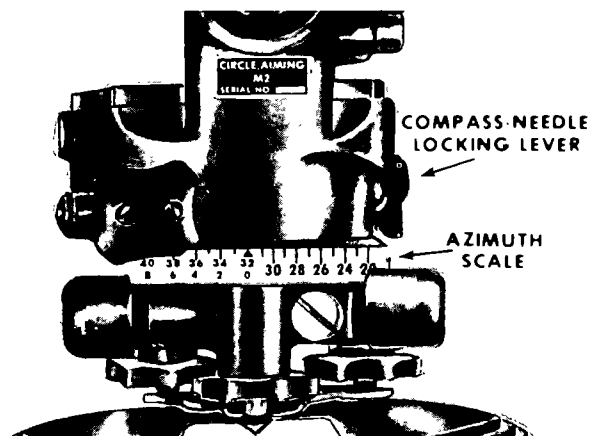
b. Reflector. The reflector (2) is a plastic signal post mounted on top of the telescope and is used as an aiming point for other instruments sighting on the aiming circle.

c. Elevation knob. The elevation knob (3) is used to raise and lower the telescope in order to sight on the sight of a weapon or some other aiming point. The elevation scales are not used during laying and measuring.

d. Magnetic compass. The magnetic compass (4) is located in the oblong recess in the top of the body assembly. For rough centering, the magnetic needle may be seen through the windows on top of the body assembly. A small glass magnifier (5) and reticle with three vertical lines are at one end of the recess to aid in alining the end of the magnetic needle. When the locking lever is in



a vertical position, the needle is locked. When the lever is turned either right or left to the horizontal position, the needle is unlocked. To preclude damage to the magnetic needle, this lever should be returned to the locked position gently. The needle should be locked when it is not in use!

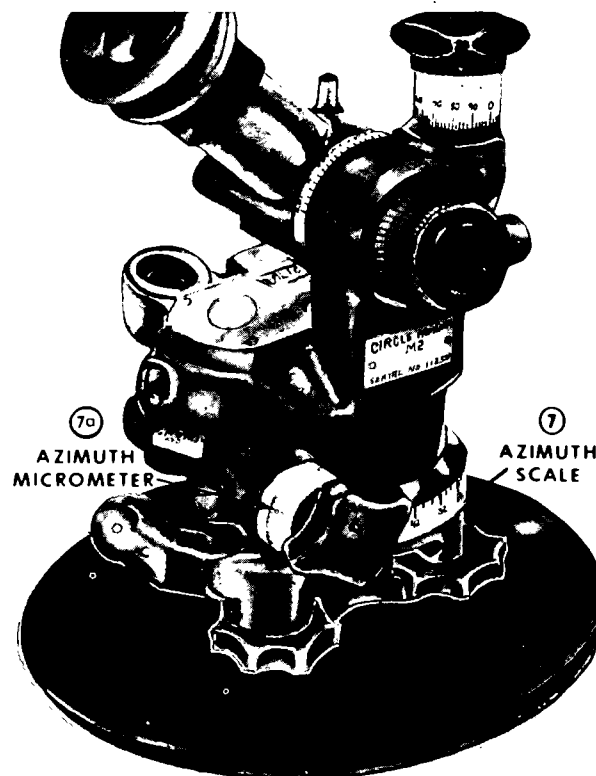
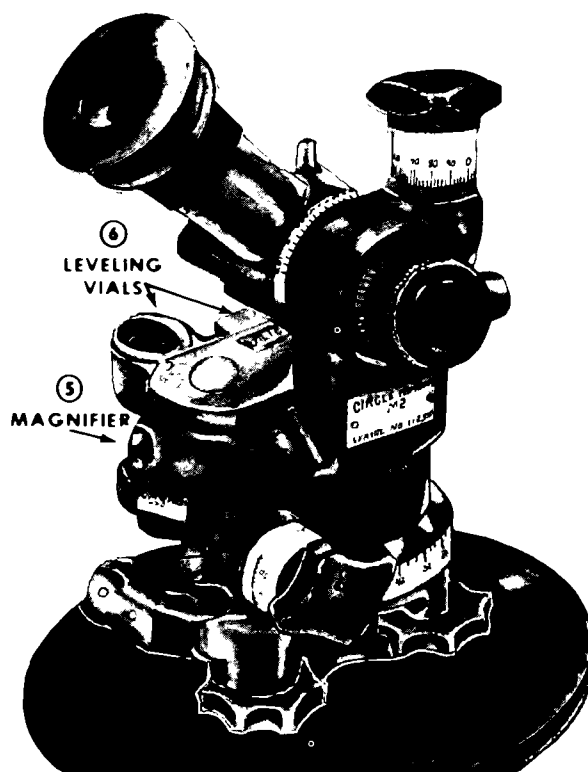


★ *e. Leveling vials.* There are two tubular leveling vials and one circular leveling vial (6) on the aiming circle. One tubular leveling vial is used in leveling the telescope so that the operator can measure vertical angles. The other tubular leveling vial or the circular leveling vial (fisheye bubble) is used in leveling the aiming circle for measuring horizontal angles. When the tubular leveling vials are not in use, the protective covers should be closed to prevent damage.

★ *f. Azimuth scale and azimuth micrometer.*

(1) The azimuth scale (7) is located below the magnetic compass housing. It is graduated in 100-mil increments from 0 to 6400 mils and is numbered every 200 mils. The portion of the azimuth scale from 3200 mils through 6400 mils has a second 0-3200 scale (numbered in red from the black 32 through the large black 0 on the azimuth scale). When orienting the aiming circle, frequent reference is made to the 0-3200 line. The 0-3200 line is an imaginary line drawn from the large black 0 through the black 3200 on the azimuth scale of the aiming circle.

(2) The azimuth micrometer (7a) is located on the azimuth knob on the lower right side of the magnetic needle housing. It is graduated in 1-mil increments from 0 to 100 mils and is numbered every 10 mils.



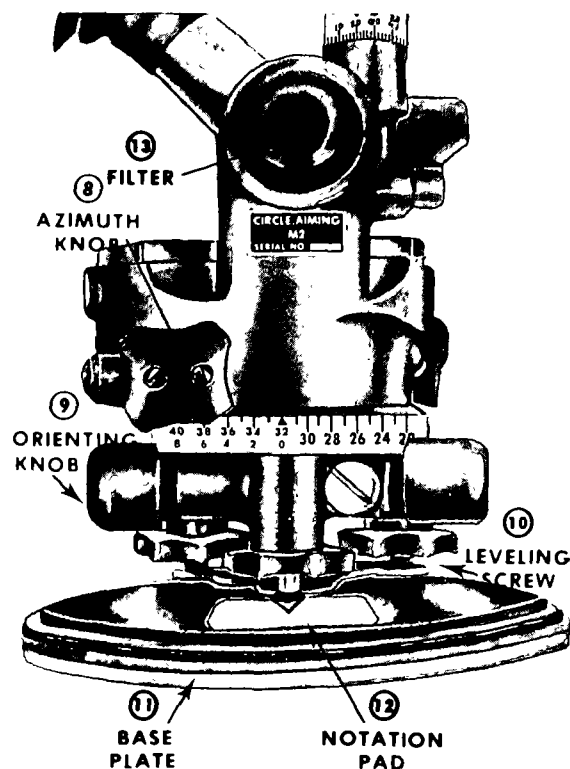
g. Upper (recording) motion. The upper motion allows the operator to place instrument readings on the azimuth scale and azimuth micrometer by means of the *azimuth knob* (8). The values are read on the azimuth scale index, which is located below the magnetic needle magnifier. The upper motion of the instrument has both a fast motion and a slow motion. Lateral movement of the azimuth knob produces fast motion. Rotation of the azimuth knob produces slow motion. Horizontal angles are read in two parts—the hundreds of mils are read from the azimuth scale and the tens and units of mils are read from the azimuth micrometer.

h. Lower (nonrecording) motion. The lower motion is controlled by the *orienting knobs* (9) and is used to orient the 0-3200 line of the aiming circle without changing the instrument reading. Lateral movement of one orienting knob produces fast movement of the lower motion of the aiming circle. The two orienting knobs should be used simultaneously for slow movement of the lower motion. Caps are provided for covering the orienting knobs to prevent unintentional use of the lower motion.

i. Leveling screws. The three leveling screws (10) are used to level the aiming circle. These screws are on a spring plate located below the orienting knobs and above the base plate assembly.

j. Base plate assembly. The base plate assembly (11) is the base of the instrument when it is mounted on the tripod and also serves as the base of the carrying case. It is a flat circular plate to which the instrument is attached by means of the spring plate. An instrument-fixing screw is threaded into a socket on the underside of the base plate assembly to attach the instrument to the tripod. The socket is kept clean and free of obstructions by a spring-loaded cover that remains closed when the instrument is not attached to the tripod. The base plate is fitted with a rubber gasket that forms a watertight seal when the cover is latched to the base plate.

★ *k. Notation pad.* A rectangular *notation pad* (12) on the base plate is used for recording



the declination constant, date of declination, vertical angle correction, and initials of the person performing the declination.

l. Filter. A filter (13), which is placed over the eyepiece for protection against the sun's rays, is stored on the cover side of the telescope body, where it is held in place by a spring-loaded ball.

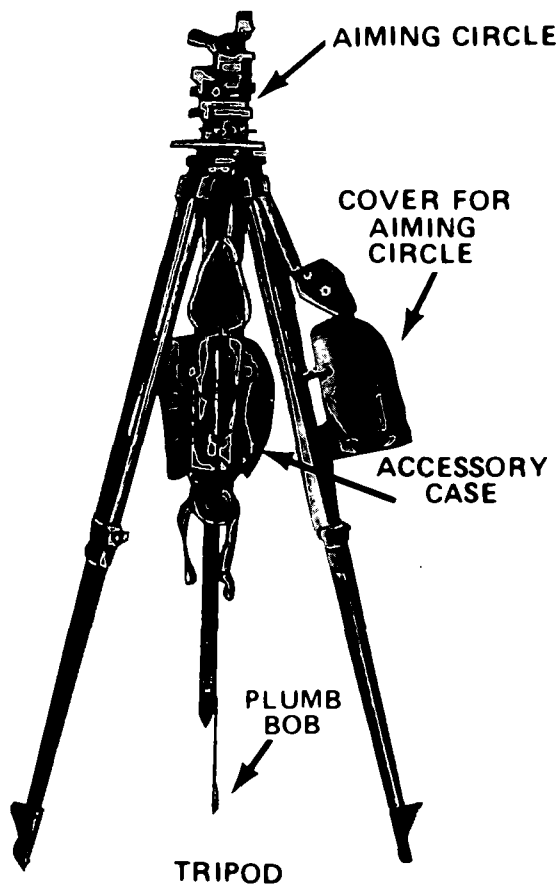
8-3. Setting Up The Aiming Circle

To set up the aiming circle—

a. Unstrap the legs of the tripod, loosen the leg clamp wing screws, and extend the legs to the desired length. Tighten the leg clamp wing screws.

b. Place the tripod over the point to be occupied. One tripod leg should be pointing in the approximate direction of sighting, and the leg with the night light mount should be to the operator's left. The head of the tripod should be at a height that will place the telescope at a height convenient for the operator.

c. Firmly embed the tripod legs. Make sure the tripod head is approximately level when the legs are embedded, then remove the tripod head cover.



d. Pull back the spring plate on the base of the base plate and place the aiming circle on the tripod. Loosely screw the instrument-fixing screw into the base plate.

e. Attach the plumb bob to the hook under the instrument-fixing screw and center it over the orienting station by moving the base plate of the aiming circle. The plumb bob should be approximately 1 inch above the station marker.

f. Remove the aiming circle head cover, and hang it on the tripod head cover to prevent damage.

g. Screw the instrument-fixing screw into the base plate of the aiming circle.

CAUTION: BE CAREFUL NOT TO EXERT EXCESSIVE PRESSURE WHEN TIGHTENING THE INSTRUMENT-FIXING SCREW OR THE SLOTTED ARM WILL BEND AND DAMAGE THE TRIPOD HEAD.

h. Install the night lighting device accessory case if necessary. The aiming circle should now look like the one pictured here.

COMMON MALPRACTICES

Not clearing the area of magnetic attractions such as weapons, steel helmets, and eyeglasses.

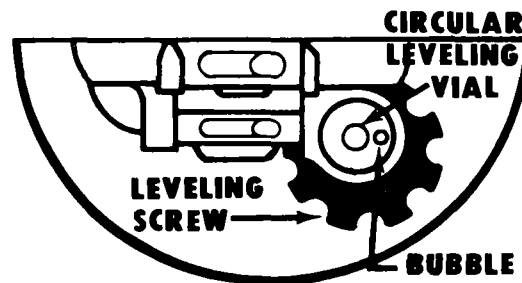
Failure to set up the tripod so that one leg points in the direction of the sighting. This puts one more tripod leg in the instrument operator's way as he moves around and increases the likelihood that he'll kick a leg and knock the aiming circle off level.

★8-4. Leveling the Aiming Circle

There are two methods of leveling the aiming circle for normal use, using either the circular or the tubular leveling vials.

a. To level the aiming circle using the circular leveling vial (fisheye bubble) method:

(1) Loosen the leveling screws approximately halfway.



(2) Rotate the head of the aiming circle until the circular leveling vial is over one of the three leveling screws at the bottom of the aiming circle.

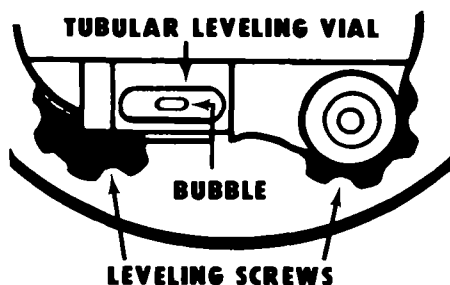
(3) Using the thumb and forefinger of each hand, turn the other two leveling screws in opposite directions. The bubble will move in the same direction as the left thumb.

(4) When the bubble moves on line with the fisheye, center the bubble by using only the third leveling screw. Move the head over each of the other two screws. If more than half the bubble moves out of the center ring,

relevel the instrument. If the bubble cannot be centered, use the technique discussed in *b* below and turn the instrument in for repair as soon as possible.

b. To level the aiming circle using the tubular leveling vial:

(1) Loosen the leveling screws to expose sufficient threads (three-eighths to one-half inch) on the three screws to permit the instrument to be leveled. Rotate the instrument until the axis of the tubular leveling vial is parallel to any two of the three leveling screws. Center the bubble by using these two leveling screws. Grasp a screw between the thumb and forefinger of each hand. Turn the screws simultaneously so that your thumbs move either toward each other or away from each other. This movement tightens one screw as it loosens the other. The bubble always moves in the same direction as the left thumb.



(2) Rotate the instrument 1600 mils, and center the bubble by turning the third leveling screw.

(3) Rotate the instrument back to the first position, and relevel the bubble if necessary.

(4) Repeat these steps until the bubble remains centered in both positions.

(5) Rotate the instrument 3200 mils from the first position. If the bubble remains centered in this position, rotate the instrument 3200 mils from the second position. If the bubble remains centered in this position, rotate the instrument throughout 6400 mils. If the bubble remains centered, the instrument is level. If the bubble does not remain centered when the instrument is rotated 3200 mils from the first position, the leveling vial is out of adjustment. To compensate, using the same

leveling screws that were used to place the instrument in the first position, move the bubble halfway back to the center of the leveling vial. Rotate the instrument 3200 mils from the second position, and using the other leveling screw, move the bubble halfway back to the center of the level vial. The instrument is now level, and the bubble should come to rest in its vial at the same off-center position (within one graduation) regardless of the direction in which the instrument is pointed. If the leveling vial is out of adjustment, the instrument should be turned in for repair at the first opportunity.

★8-5. Taking Down the Aiming Circle

To take down the aiming circle—

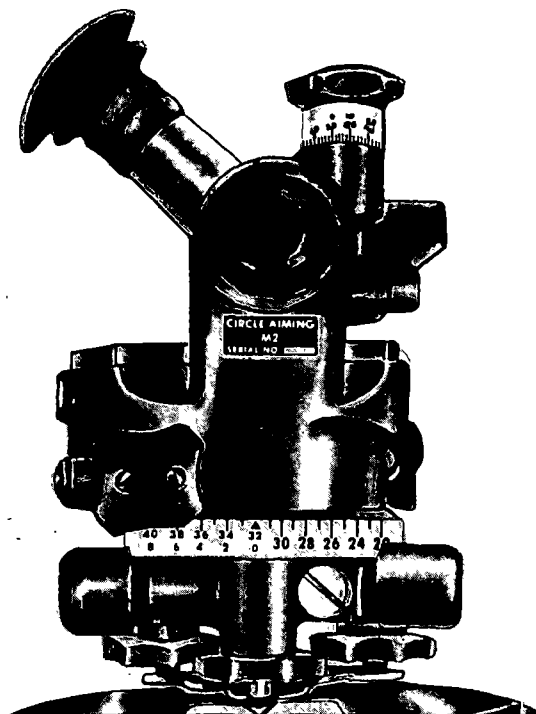
a. Tighten the leveling screws to their lower stops and then loosen each screw one-quarter turn.

b. CHECK TO INSURE THAT THE MAGNETIC NEEDLE IS LOCKED.

c. Cover the leveling vials.

d. Make sure that the caps of the orienting knobs are closed.

e. Place the azimuth knob over the notation pad. The aiming circle should now look like this:



f. Place the carrying case cover over the aiming circle and latch the cover locks.

g. Unscrew the instrument-fixing screw and remove the instrument from the tripod.

h. Replace the tripod head cover.

i. Retract and collapse the tripod legs and tighten the wing screws.

j. Strap the tripod legs together.

★8-6. Declinating the Aiming Circle

a. To determine the declination constant for each instrument and to keep this declination constant current, certain rules have been prescribed outlining how often and under what circumstances the aiming circle should be declinated. The aiming circle must be declinated—

(1) After an electrical storm or any time the instrument has received a severe shock; e.g., if it is dropped from the bed of a truck to the ground. The magnetic needle is a delicately balanced mechanism, and any shock may cause a significant change in the declination constant for the instrument.

(2) Any time the aiming circle is moved 25 miles or more from the area in which it was last declinated. Because of local magnetic attractions, any move of the aiming circle may result in an appreciable change in the relationship of grid north and magnetic north as measured by the instrument.

(3) A minimum of once every 30 days to determine if any changes in the declination have occurred because of the annual shift of magnetic north or because of accidents involving the instrument that may not have been reported. If a radical change is observed, the instrument should be declinated again within a few days to determine if the observed change is a result of a magnetic storm or is a real change in the characteristics of the instrument.

(4) When it is initially received and any time it is returned from ordnance repair.

b. Variations in the declination constant at different times of the day are not significant enough to warrant declinating at any specific time.

c. There are certain factors that must be considered in determining the location at which an aiming circle is to be declinated.

(1) A declination station should be established at a place that is convenient to the using unit. It may be established by battalion or other higher headquarters, or by the target acquisition battery.

(2) From the declination station there should be known azimuths to two or more azimuth marks, preferably in opposite directions. These azimuth marks should be at least 1000 meters from the declination station, but they may be a minimum distance of 300 meters if necessary.

(3) Declination stations should be established in an area free from magnetic attractions.

d. When a declination station is available, declinate the aiming circle as follows:

(1) Set up the aiming circle directly over the declination station, then level the circle.

(2) With the upper motion, set the known azimuth to the azimuth mark on the scales of the instrument.

(3) With the lower motion, sight on the first azimuth mark.

(4) Release the magnetic needle. With the upper (recording) motion, center the needle.

(5) Read the declination constant directly from the scales (to the nearest 0.5 mil).

(6) Relevel the aiming circle, if necessary, and, using a second azimuth mark if one is available, repeat the above steps. (If a second azimuth mark is not available, use the first azimuth mark again.)

★ (7) Compare the two declination constants determined. If they agree within 2 mils, determine the mean, express it to the nearest whole mil using standard artillery expression, and record the mean (four-digit number), the date, and the initials of the individual performing the declination on the notation pad.

IF THE TWO VALUES DIFFER BY MORE THAN 2 MILS, REPEAT THE ENTIRE PROCESS.

e. In a rapidly moving situation, time may not permit the establishment of a declination station by battalion surveyors. Under such circumstances a declination station can be established by simultaneous observation or by observation of Polaris. See chapter 9.

f. A third method of declinating, if an accurate position can be determined, is to scale a grid azimuth to two distant points. The following procedures are used:

(1) Place the aiming circle over the selected point and level the instrument.

(2) Select two distant points that can be identified on a map and scale the direction to them from the occupied point.

(3) Using the direction scaled from the map, declinate the aiming circle by the procedures previously discussed.

(4) Compare the two values determined. They must agree within 10 mils.

(5) If the values determined agree within 10 mils, determine the mean, and record it on the notation pad. If the values do not agree within 10 mils, repeat the entire procedure.

A DECLINATION CONSTANT DETERMINED BY SIMULTANEOUS OBSERVATION OR FROM A MAP SHOULD BE VERIFIED AS SOON AS POSSIBLE.

★8-7. Measuring Azimuth to a Point

a. The aiming circle can be used to measure an azimuth as follows:

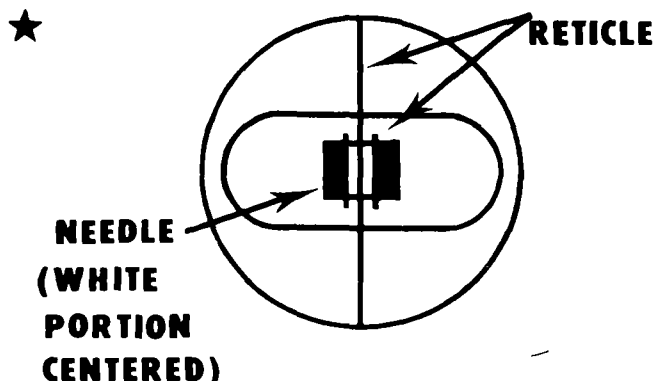
(1) Place the aiming circle so that the 0-3200 line is in an approximate north-south direction and the large 0 of the scale is toward the south.

(2) Check the notation pad to determine the declination constant for your aiming circle.

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(date)
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Then, with the upper motion, set off the declination constant.

(3) Release the needle and, with the lower motion, center the needle to direct the line of sight to magnetic north and the 0-3200 line of the instrument to grid north. When it is centered, the magnetic needle looks like this—



(4) Lock the needle and, with the upper motion, refer the line of sight to the desired point. Read the grid azimuth from the azimuth scale and the azimuth micrometer.

b. For greater accuracy, repeat this operation. If the two azimuth determinations agree within ± 2 mils, determine the mean, and record the measured grid azimuth to the nearest 0.1 mil. If they do not agree, repeat the entire procedure.

★8-8. Care and Handling

The aiming circle must be treated with care. It will not stand abuse! The declination constant that is so painstakingly determined may very well be worthless if the aiming circle is dropped or handled in a rough manner. To get maximum service from the aiming circle:

a. Protect it from shock. Often in a fast-moving situation the executive officer (XO) or the chief of firing battery (CFB) will want to keep the aiming circle head attached to the tripod during movement. This practice is fine and reduces setup time. Extra care must be taken, however, to preclude damage to the instrument when transported in this manner.

b. The declination constants of the two aiming circles of the battery should be

compared periodically. To make this comparison—

(1) Set the aiming circles up at least 10 meters apart and level them.

(2) Using the method described in paragraph 8-7, have each instrument operator measure the azimuth to the other instrument. (One operator will have to either add or subtract 3200 mils.) If the azimuths do not compare within 10 mils, both aiming circles should be redeclinated as soon as possible.

c. Never attempt to force the rotation of any knob past the stops.

d. Keep the instrument clean and dry.

e. Clean the lens with a camel's-hair brush and lens tissue ONLY.

f. Keep the magnetic needle *locked* any time it is not in use.

g. Place the aiming circle head cover over the aiming circle head for protection whenever it is to be left set up.

h. Be sure all tubular leveling vials are covered when not in use.

i. Be sure to rotate the azimuth knob until it is over the notation pad before attempting to replace the aiming circle head cover.

Section II. RECIPROCAL LAYING

★8-9. General

Reciprocal laying is a procedure by which the 0-3200 line of one instrument and the 0-3200 line of another instrument are laid parallel. When the 0-3200 lines of an aiming circle and a panoramic telescope are parallel and the piece has been boresighted properly, the tube of the piece is parallel to both 0-3200 lines. The principle of reciprocal laying is based on the geometric theorem that if two parallel lines are cut by a transversal, the alternate interior angles are equal. The parallel lines are the 0-3200 lines of the instruments, and the transversal is the line of sight between the two instruments. The alternate interior angles are the equal deflections placed on the instruments (fig 8-1).

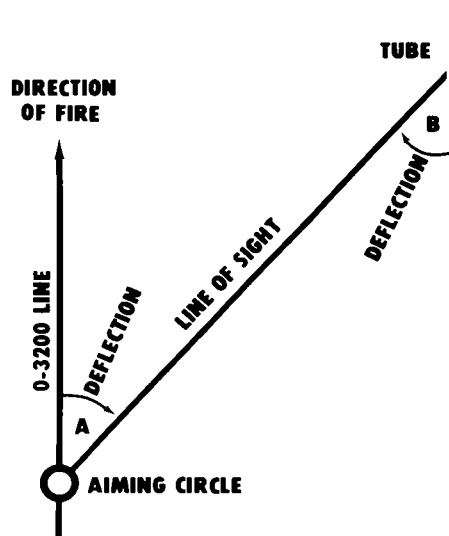


Figure 8-1. Principle of reciprocal laying.

★8-10. Procedures

a. After the 0-3200 line of the aiming circle has been established parallel to the direction of fire, the instrument operator, using the upper motion, sights on the lens of the panoramic telescope, reads the deflection on the azimuth and azimuth micrometer scales, and announces it to the gunner on the piece.

IF THE WEAPONS ARE EQUIPPED WITH M12-SERIES SIGHTS, DEFLECTION CANNOT EXCEED 3200 MILS; therefore, the red numbers on the aiming circle may have to be read if the aiming circle reading (black numbers) exceeds 3200 mils. The gunner sets off the announced deflection on the panoramic telescope and orders the

weapon to be shifted, and/or traverses the tube, until the line of sight through the panoramic telescope is again on the reflector of the aiming circle.

b. Because the panoramic telescope is offset laterally from the axis about which the carriage of the weapon is moved, the panoramic telescope is displaced horizontally. When the telescope has been sighted on the aiming circle, the gunner reports READY FOR RECHECK, and the instrument operator again sights on the lens of the telescope and reads and announces the deflection. This procedure is repeated until the gunner reports a difference of 0 mils between successive deflections. The piece has then been laid reciprocally.

c. The last deflection announced to each weapon should be recorded by the instrument operator in the event it is needed by the FDC in computing position corrections.

d. In some cases, all pieces will not be able to see the aiming circle, and one piece will be used to lay the others. If weapons are equipped with the M100-series panoramic telescopes, the readings between any two weapons will be 3200 mils apart. To prevent confusion, the gunner on the laying piece should add/subtract 3200 mils to/from his reading before announcing it to another howitzer. If the howitzer to which the laying gunner is referring is on his left, the gunner must add 3200; if it is on his right, he must subtract 3200. Reciprocal laying with the M107 or M110/M110A1/A2 may not be possible because of the position of the sight mount and tube.

e. In order of decreasing accuracy, the methods available to lay the battery are:

(1) *M2 aiming circle method using the orienting angle.* This method requires that a known azimuth be established by the battalion survey section or by use of one of the hasty survey techniques discussed in chapter 9.

(2) *M2 aiming circle method using the magnetic needle.* This method should be used only when surveyed data cannot be established.

(3) *M2 compass method.*

f. In addition, two methods of laying without the aiming circle (for emergency missions) are used. They are:

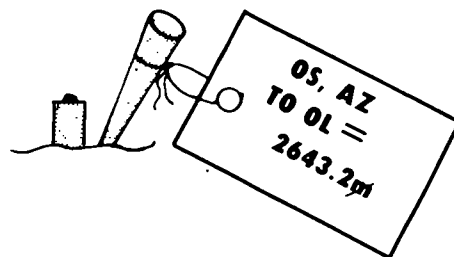
(1) *The aiming point-deflection method.*

(2) *The howitzer backlay method.*

★ g. Memory aids and procedures for laying the battery are shown in table 8-1.

★8-11. Laying by Orienting Angle

a. To lay the battery by orienting angle, an orienting line must be established. The executive officer may be given the orienting line by the survey section, may find the information on a tag attached to the stake marking the orienting station (OS), or may have determined it himself through simultaneous observation or observation of Polaris (see chap 9).



★ b. Using the plumbline, he sets up the aiming circle over the small stake marking the OS. The large stake points toward the end of the orienting line (EOL). The executive officer can compute the orienting angle (fig 8-2) by subtracting the azimuth of fire from the azimuth of the orienting line. He uses the upper motion to set the orienting angle on the aiming circle and uses the lower motion to sight the aiming circle on the EOL. The 0-3200 line is now parallel to the azimuth of fire.

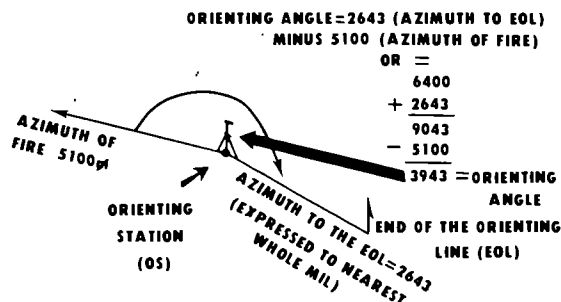


Figure 8-2. Computation of orienting angle.

★**EXAMPLE.** The battery is being laid. The orienting angle is 3943.

(1) Set up the aiming circle over the orienting station.

(2) Roughly orient the 0-3200 line along the azimuth of fire.

(3) Using the UPPER motion, set off 3943, using black numbers only.

(4) Making certain that the index remains at 3943, use the LOWER motion and sight on the EOL. The line of sight now coincides with the orienting line. The 0-3200 line of the aiming circle is in the desired direction of fire.

(5) After the 0-3200 line of the aiming circle has been established in the desired direction of fire, the next step is to lay the battery reciprocally using the upper motion. This makes the tubes of the howitzers parallel to the 0-3200 line of the instrument, and thus oriented on the azimuth of fire.

ALWAYS VERIFY THE DIRECTION OF FIRE BY MEASURING THE AZIMUTH OF THE ORIENTING LINE OR BY MEASURING THE AZIMUTH OF FIRE AND COMPARING IT WITH THE COMPUTED AZIMUTH OF FIRE.

★8-12. Laying by Grid Azimuth

If surveyed data are not available and hasty survey is not possible, the next best method of orienting the aiming circle is to use the magnetic needle.

a. To orient the aiming circle on a grid azimuth using the magnetic needle—

(1) Determine the instrument reading to be placed on the instrument by subtracting the azimuth of fire from the declination constant of the aiming circle (adding 6400 mils to the declination constant, if necessary).

(2) Using the UPPER motion, place this value on the aiming circle.

(3) Sight on magnetic north by centering (with the LOWER motion) the magnetic needle.

b. The next step is to lay the battery parallel, using the UPPER motion. Because laying by azimuth involves the use of the magnetic needle of the aiming circle, the instrument must be set up where it is free from magnetic attractions. The minimum distances that should be observed are:

Powerlines and electronic equipment 150 meters.

Railroad tracks, artillery*, tanks and vehicles 75 meters.

Barbed wire, personal weapons, and small metallic objects 10 meters.

*These distances apply to all calibers of cannon weapons.

The following is an example of laying the battery by grid azimuth:

(1) The command to lay the battery on azimuth 5350 has been received. The declination constant of the aiming circle is 200 mils.

(2) Subtract the azimuth of fire from the declination constant. Since the larger number (5350 mils) cannot be subtracted from the smaller number (200 mils), 6400 mils must be added to the smaller number. Thus, $6400 + 200 = 6600$ mils; $6600 - 5350 = 1250$. The horizontal, clockwise angle from the desired direction of fire to magnetic north (aiming point) is 1250 mils (fig 8-3).

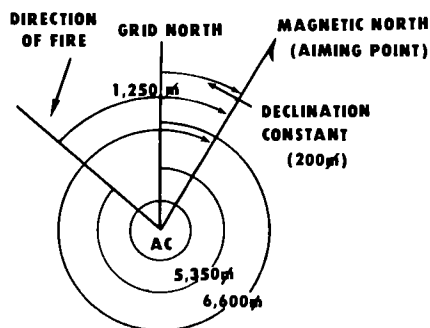


Figure 8-3. Principles of laying by grid azimuth.

(3) With the single 0 of the aiming circle nearest him and the 0-3200 line pointing generally in the direction of azimuth 5350, the instrument operator should use the UPPER motion to set off 1250.

(4) Making certain that the index remains at 1250, center the magnetic needle by using the LOWER motion. This action places the 0-3200 line of the aiming circle in the desired direction of fire; i.e., on grid azimuth 5350.

(5) After establishing the 0-3200 line of the aiming circle on grid azimuth 5350, lay the battery reciprocally by using the UPPER motion. This procedure places each howitzer tube on grid azimuth 5350.

★8-13. Commands

The following commands are used in laying a battery with an aiming circle. The deflections announced are examples only. For brevity, only the exchange between the instrument operator and the gunner of number 3 is given.

Instrument operator:

**BATTERY ADJUST,
AIMING POINT
THIS INSTRUMENT.**

(All gunners identify the aiming point. Normally, pieces are laid in the order of their readiness.)

Gunner of number 3:

**NUMBER 3, AIMING
POINT IDENTIFIED.**

(Each gunner gives a similar response. Using the UPPER motion, the instrument operator turns the head of the aiming circle until the line of sight is on the telescope of the number 3 piece and reads the azimuth and azimuth micrometer scales.)

Instrument operator:

**NUMBER 3,
DEFLECTION 3091.**

Gunner of number 3:

**NUMBER 3,
DEFLECTION 3091.**

(The gunner then sets the deflection on his sight and traverses the weapon until he is sighted back on the aiming circle.)

Gunner of number 3:

**NUMBER 3,
READY FOR RECHECK.**

(The instrument operator again turns the head of the aiming circle until the line of sight is on the telescope of the number 3 piece and announces the deflection.)

Instrument operator:

**NUMBER 3,
DEFLECTION 3093.**

(This indicates a difference of 2 mils from the original deflection of 3091, which the gunner now has on the panoramic telescope. The gunner sets 3093 on the telescope and again traverses the tube until he is sighted on the aiming circle. Meanwhile, the instrument operator may or may not proceed with the laying of the other pieces. As a general rule, when the gunner of any piece announces a difference of 10 mils or less, the instrument operator continues to lay that particular piece until it is laid.)

Gunner of number 3:

**NUMBER 3,
DEFLECTION 3093,
2 MILS.**

The gunner then announces:

**NUMBER 3, READY
FOR RECHECK.**

Instrument operator:

**NUMBER 3,
DEFLECTION 3093.**

Gunner of number 3:

**NUMBER 3,
DEFLECTION 3093,
0 MILS.**

(Rechecking of each piece must continue in this manner until the deflection announced by the instrument operator and the deflection on the panoramic telescope are identical.)

Instrument operator:

**NUMBER 3
IS LAID.**

★8-14. Laying the Battery Without an Aiming Circle

If an operational aiming circle is not available, the following methods of laying the battery may be used. The methods in *b* and *c* below are recommended for emergency situations.

a. M2 compass method.

REMEMBER TO SET THE DECLINATION CONSTANT ON THE M2 COMPASS.

(1) Place the M2 compass on a steady object away from magnetic attractions and where it can be used as an aiming point for the base piece. The aiming circle tripod, if available, is excellent for this purpose.

(2) Measure the azimuth to the panoramic telescope of the base piece. Compute a deflection by subtracting the announced azimuth of fire from the azimuth measured to the panoramic telescope of the base piece (adding 6400 mils, if necessary.)

(3) Command:

**BASE PIECE ADJUST (or
NUMBER (so-and-so) ADJUST),
AIMING POINT THIS INSTRUMENT,
DEFLECTION (so much).**

The gunner sets the announced deflection on the sight, moves the weapon and/or traversing mechanism until he is sighted on the instrument, and announces:

**NUMBER (so-and-so), AIMING
POINT IDENTIFIED, DEFLECTION
(so much).**

The instrument operator commands:

**BASE PIECE IS LAID,
BATTERY ADJUST,
AIMING POINT BASE PIECE
(or AIMING POINT
NUMBER (so-and-so)).**

(4) The gunner of the base piece then reciprocally lays the other pieces. He uses the panoramic telescope and the procedure explained in paragraph 8-11.

b. Aiming point-deflection method. The aiming point and deflection method is used primarily for a rapid occupation of position; however, it can be used for a deliberate occupation in the absence of an aiming circle or an M2 compass. The XO should lay the base piece and then have the base piece gunner lay the battery reciprocally.

(1) Determine the azimuth from the battery center to a distant aiming point (DAP). To compute a deflection, subtract the *back-azimuth* of fire from the azimuth determined to the distant aiming point.

(2) To lay the battery, command:

**BATTERY ADJUST, AIMING POINT
(so-and-so) (location), DEFLECTION
(so much).**

(3) Each gunner sets off the announced deflection, sights on the aiming point by traversing, then announces:

**NUMBER (so-and-so), AIMING POINT
IDENTIFIED, DEFLECTION
(so-much).**

(4) When all sections have so reported command:

THE BATTERY IS LAID.

WHEN THE BATTERY IS LAID BY THE AIMING POINT AND DEFLECTION METHOD, THE SHEAF TENDS TO CONVERGE IF THE AIMING POINT IS TO THE FRONT AND TENDS TO DIVERGE IF THE AIMING POINT IS TO THE REAR; THEREFORE, IT IS PREFERABLE TO USE AN AIMING POINT ON THE FLANK.

c. Howitzer backlay method. In an emergency, when time is critical and a DAP is not available, the howitzer backlay method may be used. With training and practice, the battery can perform this method as accurately and quickly as the aiming point-deflection method. Upon receipt of a fire mission, the XO pulls into a firing position and aligns the front of his vehicle roughly on the azimuth of fire. His driver assists him in aligning two stakes and the battery is laid by the following procedure:

(1) The XO drives in the rear stake and uses the M2 compass to align the far stake on the azimuth of fire. He then drives in the far stake. (Distance between stakes should be equal to the length of the howitzer.) (A)

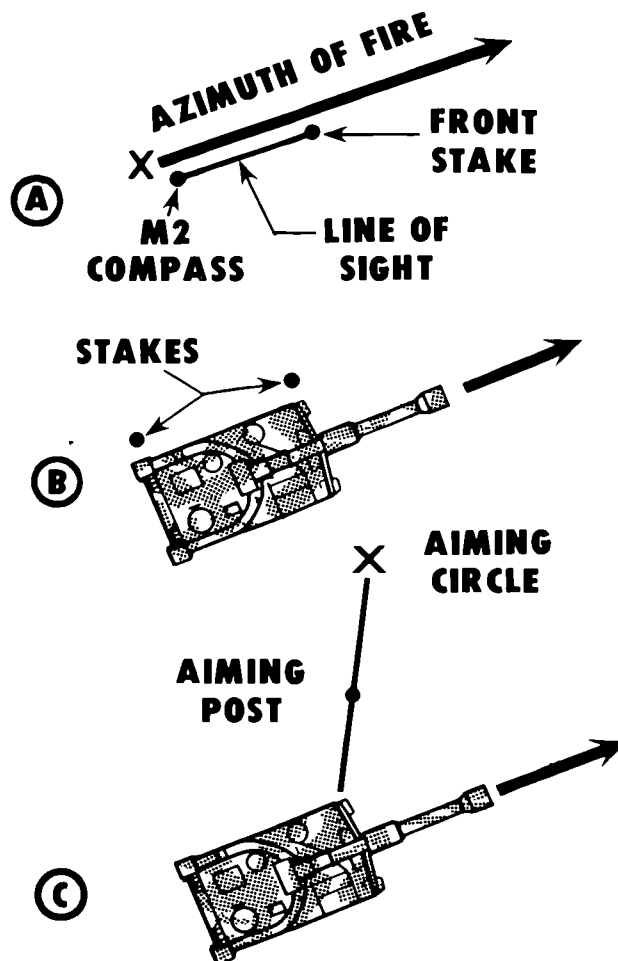
(2) The XO guides the base piece into position and aligns it parallel to the stakes. With the tube still in the center of traverse position, the base piece fires the first round with the quadrant and charge determined by the XO or FDC. (B)

(3) While the base piece is firing the first round, one man sets up the aiming circle in the appropriate position to lay the rest of the battery. After the first round is fired, the instrument operator commands:

**BASE PIECE, AIMING POINT
THIS INSTRUMENT, REFER.**

The gunner on the base piece refers to the aiming circle and replies:

**BASE PIECE, AIMING POINT
IDENTIFIED, DEFLECTION
(so much).**



★ The instrument operator places the referred reading on the aiming circle using the upper motion, sights on the base piece with the lower motion, and then lays the remainder of the battery by standard procedures. The gunner on the base piece places an aiming post halfway between himself and the aiming circle to be used as an aiming point, and the remaining pieces emplace collimators.

★8-15. Establishing Aiming Points

a. Under normal circumstances, after the battery has been laid, the crew of each piece is directed to set up the collimator or aiming posts before the tube is moved. The deflections at which the aiming points are established are recorded by the gunner. Furthermore, the direction in which the battery is initially laid and the corresponding deflection are used as references from which

the FDC can derive firing deflections for future targets.

- ★ *b.* The collimator is the primary aiming point and is placed 4 to 15 meters from the sight of the weapon. When the collimator is emplaced, 3 numbers (such as 5, 0, 5) or 11 graduations must be visible in the reticle. If possible, place the collimator under cover to the left or left front of the weapon. Be sure that the collimator is emplaced so that the power cable will reach the weapon (SP weapons only). When aiming posts are used, the far aiming post should be placed 100 meters from the piece and the near aiming post should be placed 50 meters from the piece. If the situation or terrain limits placing the far aiming post 100 meters from the piece, place it out as far as possible and place the near aiming post halfway between the piece and the far aiming post. For example, if the far aiming post is placed 80 meters from the piece, the near aiming post would be placed 40 meters from the piece.

c. As soon as the battery is laid and the aiming point(s) is (are) emplaced, the XO should have the gunners of all pieces refer to a distant aiming point if one is available. This DAP can be used as the primary aiming point if something happens to the collimator or aiming posts. For example, the XO may command:

**AIMING POINT, STEEPLE RIGHT
FRONT, REFER, RECORD
REFERRED DEFLECTION.**

Each gunner refers to the steeple and records the deflection for future use.

★8-16. Verifying Laying for Direction

a. After the battery has been laid, there are certain checks that should be made to insure that no weapon has been laid in error and that the pieces have been laid parallel and in the proper direction. To check parallelism, each gunner checks reciprocally with at least one other piece. If the deflections used by the gunners agree, the pieces are parallel. *Caution must be used in checking with the M100-series sights, since the reading from one sight to another will differ by 3200 mils.* Further, one of the firing battery supervisors

should walk the line of metal and visually check the parallelism of the tubes.

b. As soon as time permits, the following check should be made.

(1) With another aiming circle (if available) command:

**NUMBER (so and so),
AIMING POINT
THIS INSTRUMENT, REFER.**

(2) The gunner of the piece indicated announces **AIMING POINT IDENTIFIED**, turns the sight of the piece until the line of sight is on the designated instrument, and announces the reading on the azimuth counter (or nonslipping azimuth scale) as:

**NUMBER (so-and-so), DEFLECTION
(so much).**

(3) The instrument operator sights on the panoramic telescope of the designated piece.

(4) If the deflection read by the gunner does not agree with that read from the instrument, the instrument operator can correct it by giving the gunner the proper deflection and re-laying the weapon.

★8-17. Laying by Aircraft, High Airburst, or Flare

a. The battery may be laid initially for direction by sighting with an instrument on an aircraft, a high airburst, or a flare. This procedure is valid when the entire battalion is placed on a common direction.

b. When no visible point is suitable for use as an aiming point, an *aircraft* may fly over the battery position toward, or away from, a point in the target area to indicate an azimuth of fire.

c. If a *high airburst* or a *flare* is to be used, it should be fired over the target area. The high airburst is fired by another unit that has been laid previously for direction. The flare may be fired by an air observer or a ground observer.

d. To lay the battery by aircraft, high airburst, or flare, use the following procedure:

(1) Set up the aiming circle where it can be used as an aiming point by all pieces.

(2) Zero the azimuth scale and azimuth micrometer scale and, using the lower motion, align the vertical hairline on the aircraft, airburst, or flare.

(3) Using the upper motion, lay the pieces reciprocally by standard procedures.

★8-18. Training

a. The battery must be prepared to deliver fire as quickly as possible after getting to the firing position. This means that the laying process must be completed as quickly as possible. Personnel who lay the battery must be *fast and accurate*. This requires training.

b. As a minimum, the following personnel should know how to lay the battery:

All officers.

The chief of firing battery.

The gunnery sergeant.

The first sergeant.

All howitzer section chiefs.

c. Training should start initially in a local training area. A card made up in the format indicated in table 8-1 should be issued to each trainee to use until he has mastered the math and procedural steps. Trainees should be encouraged to use the memory aids to jog their memories.

d. GTA 6-1-2, the Firing Battery Supervisor's Ready Reference Square, is very handy for trainees to use after they have been trained in laying procedures.

e. How to avoid common mistakes and malpractices discussed in appendix G should be emphasized.

f. To maximize training effectiveness, a howitzer with a crew of at least a gunner and an assistant gunner should be provided for each trainee. Radio or wire communications should be established between the aiming circle and the howitzer. The trainer should emphasize use of proper commands.

g. As soon as the trainee has mastered the math and procedural steps for all methods of laying, he should be drilled frequently to develop speed in—

Setting up and leveling the aiming circle.

Determining initial instrument readings.

Centering the magnetic needle of the aiming circle.

Scaling azimuths from a map.

Accurately measuring azimuths with the M2 compass. This will develop the proficiency needed to lay by the howitzer backlay method.

h. The commander should designate various people to lay the battery during field training exercises in order to maintain proficiency and develop confidence.

Table 8-1. How to Lay the Battery

WITH THE M2 AIMING CIRCLE		
If survey is available, use the azimuth (AZ) to the end of the orienting line (EOL) and AZ of fire		
SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	Take the fire out of Old Lady	Az to EOL - az of fire = Orienting Angle (OA).
Do this SECOND	U	Set the OA on the aiming circle with the Upper motion
Do this THIRD	L	Sight on the EOL with the Lower motion
Do this LAST	U	Sight on the pantel with the Upper motion
REMEMBER: ULU		

Table 8-1. How to Lay the Battery—continued

If no survey is available, use the declination constant (DC) and the AZ of fire.

SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	S A D	Subtract the Az of fire from the DC.
Do this SECOND	U	With the Upper motion, set the remainder on the aiming circle.
Do this THIRD	L	With the Lower motion, center magnetic needle.
Do this LAST	U	With the Upper motion, sight on the panel.
REMEMBER: SAD—ULU		

WITH THE M2 COMPASS

Use AZ measured to base piece with the compass and the AZ of fire.

SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	S A M	Subtract the AZ of fire from the AZ Measured to base piece.
Do this LAST		Using proper commands, announce the resulting deflection.
REMEMBER: SAM		

BY THE AIMING POINT—DEFLECTION METHOD

Use the AZ to the distant aiming point (DAP) and the AZ of fire.

SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	AP-BAF	Aiming Point azimuth (minus) the Back Azimuth of Fire.
Do this LAST		Using the proper command, announce the resulting deflection.
REMEMBER: AP-BAF		

Table 8-1. How to Lay the Battery—continued

BY THE HOWITZER BACKLAY METHOD

Using the M2 compass, aline two stakes on the azimuth of fire and position the base piece parallel to the stakes—

SEQUENCE**PROCEDURES**

Do this FIRST	Set up the aiming circle where it can be seen by all the pieces and level it.
Do this SECOND	After the base piece fires the first round, have the gunner refer to the aiming circle.
Do this THIRD	With the UPPER motion, place the referred deflection on the aiming circle.
Do this FOURTH	With the LOWER motion, sight on the panoramic telescope of base piece.
Do this LAST	With the UPPER motion, lay the remainder of the battery.

★Section III. DETERMINING AND REPORTING DATA**★8-19. General**

The battery fire direction center requires data from the firing battery for various purposes, such as checks on the accuracy of firing charts and lay. The battery executive officer is responsible for reporting the necessary data to the FDC. This section describes the executive officer's duties in determining and reporting data.

*MINIMUM QUADRANT
ELEVATION(S),
FOR CHARGE(S) (so-and-so),
(so many mils).*

*DISTRIBUTION OF PIECES:
NUMBER 1,
DEFLECTION (so much),
DISTANCE (so many) METERS,
NUMBER 2, etc.*

(The distance from the aiming circle is to the nearest 5 meters.)

★8-20. Executive Officer's Report

a. Primary information. As soon as possible after occupying a position and laying the battery, but without interfering with firing, the executive officer reports to the FDC the information contained in the following example.

*BATTERY IS LAID,

AZIMUTH (so much),
ORIENTING ANGLE (so much)
(if applicable),

DEFLECTION (so much).*

Note. Use deflection to each weapon from the aiming circle. When time permits, the distribution of pieces should be submitted in the form of a position area sketch.

b. Supplementary information. No element of the report is delayed until data for another element have been determined. Each element is reported as soon as it is determined. As soon as possible, the following additional information is reported to the FDC:

- (1) Amount, type, and lot numbers of ammunition.
- (2) Weight of projectile, by lot.

(3) Propellant temperature.

(4) Lateral limits (azimuths or deflections). These limits indicate the azimuths or deflections between which two-thirds of the pieces can be laid without shifting trails.

(5) Maximum elevation (high-angle fire only). This limit indicates the maximum elevation two-thirds of the pieces can achieve.

c. Memory aid LAMP. The memory aid LAMP gives the sequence and key items of the executive officer's initial report:

L Battery is Laid

A Azimuth of Fire and Deflection

M Executive Officer's Minimum Quadrant Elevation

P Distribution of Pieces

Note. Much of the supplementary information in the executive officer's report may be reported directly to the FDC by the cannon sections rather than by the executive officer.

CAUTION: IT IS CRITICAL THAT THE TUBE OF THE FIRING PIECE NOT BE MOVED PRIOR TO THE PERFORMANCE OF THE PROCEDURES IN PARAGRAPHS 8-21 AND 8-22.

★8-21. Reporting the Correct Deflection

During a mission (usually a registration) the FDC may request the executive officer to:

**REPORT THE
CORRECT DEFLECTION.**

The FDC must insure this request is made prior to announcing END OF MISSION. The executive officer goes to the piece, verifies the sight picture, and reads the deflection on the sight. If the sight picture is not correct, he makes note of the reading on the sight and then refers the sight to the correct picture (without moving the tube). The reading now on the sight is reported to the FDC:

CORRECT DEFLECTION (so much).
(See example in paragraph 8-22.)

★8-22. Determining and Reporting the Correct Azimuth

Normally, the FDC will compute the correct azimuth, based on the correct deflection reported by the executive officer. However, there may be occasions when the executive officer will have to compute it. If so, he must first determine the correct deflection (see paragraph 8-21). He then compares the correct deflection and the deflection noted on the sight before referring to the correct sight picture and applies that difference to the azimuth or orienting angle on which the piece is laid.

EXAMPLE. The battery is laid on azimuth 5000 (orienting angle 600), referred deflection 3200. A mission was fired and prior to announcing END OF MISSION, the FDC commands:

**REPORT THE
CORRECT DEFLECTION.**

The executive officer goes to the base piece and notes that the sight picture is incorrect at deflection 3300. He refers the sight to the correct picture, obtains a reading of 3310, and reports to the FDC:

CORRECT DEFLECTION 3310.

The FDC then commands:

**REPORT THE CORRECT
AZIMUTH (ORIENTING ANGLE).**

The executive officer compares the correct deflection (3310) to the deflection read before correcting the sight picture (3300) and obtains a difference of an increase of 10 mils in deflection.

**AN INCREASE IN DEFLECTION
CAUSES AN EQUAL DECREASE IN
AZIMUTH AND AN EQUAL IN-
CREASE IN ORIENTING ANGLE.**

Using this rule, the executive officer applies the 10-mil increase in deflection to the azimuth of fire (5000) and reports:

CORRECT AZIMUTH 4990
(CORRECT ORIENTING ANGLE 610).

★8-23. Measuring the Azimuth of Fire

Upon completion of a mission and prior to announcing END OF MISSION, the FDC may request the executive officer to

REPORT THE AZIMUTH.

The procedure for measuring and reporting the azimuth is as follows:

a. The executive officer sets up the aiming circle so that it is away from magnetic attractions and can be seen from the base piece. He alines the 0-3200 line approximately parallel to the tube of the base piece and verifies the correct deflection is on the piece's panoramic telescope (para 8-21).

b. The executive officer commands:

**BASE PIECE, AIMING POINT
THIS INSTRUMENT, REFER.**

c. The gunner of the base piece announces:

AIMING POINT IDENTIFIED,

turns the sight of the piece until the line of sight is on the designated instrument, and announces the reading of the sight scale as:

DEFLECTION (so much).

d. With the upper motion, the executive officer sets this reading on the azimuth and azimuth micrometer scales of the instrument and, with the lower motion, sights on the panoramic telescope of the piece.

e. The XO releases the magnetic needle and centers it, using the upper motion.

f. He determines the reading on the aiming circle and subtracts that reading from the declination constant (adding 6400 mils to the declination constant if necessary). The result is the measured azimuth.

g. Prior to sending this azimuth to the FDC, the executive officer checks to see if there is any boresighting error on the base piece (para 8-27) and applies the appropriate correction to the measured azimuth, as required. He then reports:

AZIMUTH (so many mils)

to the FDC.

h. An example of when this procedure is used is when a battery has conducted an emergency fire mission (hip shoot) and has been required to stay in the position. This procedure would be used to determine on what azimuth the battery actually fired the emergency mission (if a means other than the aiming circle was used to lay the battery) and that azimuth would be used by the FDC as the azimuth of fire for the position. Additionally, this procedure can be used by the executive officer to check the lay of the battery.

★8-24. Measuring the Orienting Angle (OA)

If the battery occupies a position without directional survey control, the executive officer will lay the battery using the grid azimuth method (para 8-12). In preparation for the establishment of common directional control by battalion or hasty survey (chap 9), the executive officer designates an orienting station (OS), usually where the aiming circle currently is, and an end of the orienting line (EOL). The EOL is marked with an aiming post and should be placed in a location easily observed from the OS. To determine the OA (fig 8-4), the executive officer:

a. Has the base piece lay the aiming circle parallel to the azimuth of lay.

b. With the upper motion of the aiming circle, refers to the EOL. The reading on the aiming circle is the OA.

c. Checks to see if there is any boresighting error on the base piece and applies the appropriate correction to the OA (para 8-27) as required.

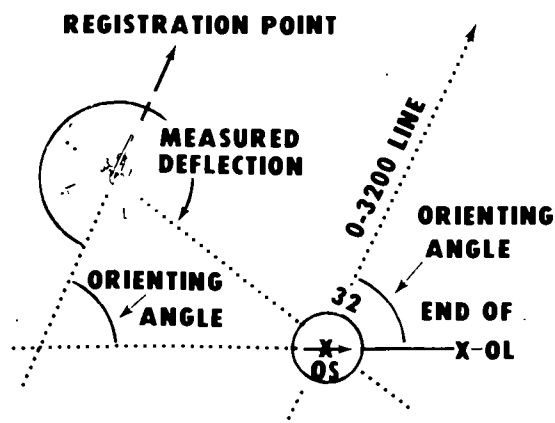


Figure 8-4. Measuring the orienting angle.

d. Reports to the FDC:

ORIENTING ANGLE (so many mils).

e. When common directional control has subsequently been established, reports the azimuth to the EOL to the FDC. FDC determines a new azimuth of lay based on the surveyed azimuth to the EOL and the executive officer's previously reported OA.

★8-25. Determining Instrument Direction

When the 0-3200 line of an aiming circle is pointing in an unknown direction, the following procedure is used for determining the grid azimuth of that direction:

a. Release the needle and center it, using the upper motion.

b. Subtract the reading on the scales from the declination constant (adding 6400 to the declination constant if necessary). The remainder is the grid azimuth of the 0-3200 line.

★8-26. Measuring Azimuth to a Point

The following procedure is used for measuring the azimuth to a point:

a. Place the aiming circle so that the 0-3200 line is in an approximate north-south direction and the large black 0 of the scale is toward the south.

b. With the upper motion, set off the declination constant.

c. Release the needle and, with the lower motion, center the needle to direct the line of sight to magnetic north and the 0-3200 line of the instrument to grid north.

d. Lock the needle and, with the upper motion, refer the line of sight to the desired point. Read the grid azimuth to the designated point from the azimuth scale and azimuth micrometer.

e. For greater accuracy, repeat this operation three times and take the average of the readings.

★8-27. Correction for Boresighting Error

a. Tactical situations, such as an emergency fire mission, may require firing

before sight tests and adjustments are made. In such cases, the pieces must be boresighted at the earliest practicable time, usually during a lull in firing. If boresighting discloses that the 0-3200 line of the sight (panoramic telescope) was not parallel to the tube, the executive officer must take corrective measures and report them to the fire direction center.

b. When a deflection is read from a sight or when an azimuth is measured, the deflection or azimuth determined is that of the 0-3200 line of the sight as read from the azimuth counter. Only if the weapon is properly boresighted is the deflection or the azimuth (orienting angle) that of the tube. When the FDC commands:

**REPORT THE AZIMUTH
(ORIENTING ANGLE),**

the azimuth (orienting angle) of the tube is desired. Therefore, if the weapon is not properly boresighted, the azimuth (orienting angle) measured is false by the amount of the error in boresighting.

c. Weapons are boresighted at the first opportunity. The azimuth counter (not the reset counter) is used during boresighting. The tube is pointed at the aiming point (either a distant aiming point, the appropriate "butterfly" on the test target, or deflection 3200 when using an alinement device), and the sight is zeroed. If the sight is pointed to the right of the appropriate aiming point, the tube is pointed to the left of the 0-3200 line of sight. It follows that any azimuth measured prior to this time was greater than the azimuth of the tube and that any orienting angle measured was smaller than the true orienting angle. If the sight is pointed to the left of the appropriate aiming point, the measured azimuth is less than the azimuth of the tube and the measured orienting angle is larger than that of the tube. The amount of the error is determined by referring the sight to the aiming point and reading the deflection. This deflection is compared with 3200, and the difference is the amount of the error in boresight. The executive officer would apply the appropriate correction for

the boresighting error to the measured azimuth or orienting angle, prior to reporting them to the FDC, and correct the lay of the piece(s) out of boresight.

d. Example 1: An M109A2 battery conducted an emergency fire mission (hip shoot) prior to boresighting the cannons. At the conclusion of the mission (and prior to announcing EOM), the FDC commands the executive officer to:

REPORT THE AZIMUTH.

Using the procedures in paragraph 8-21, the executive officer determines 3195 on the reset counter (2595 on the azimuth counter). Using the procedures in paragraph 8-23, the executive officer measures an azimuth to base piece of 1800 mils. He then directs that base piece be boresighted. During boresighting, it is noted that when the azimuth scale of the panoramic telescope is reading 3200 mils, the sight picture of the panoramic telescope is not alined on the boresighting aiming point (boresight alinement device or test target "butterfly"). Instead, it is pointed to the right of the aiming point. The sight is referred to the boresighting aiming point, and 3192 mils is read on the azimuth scale. The tube is pointed 8 mils to the left of the 0-3200 line of sight (①, fig 8-5). Therefore, the azimuth of the tube after the mission is 1792 mils ($1800 - 8$). The executive officer reports to the FDC:

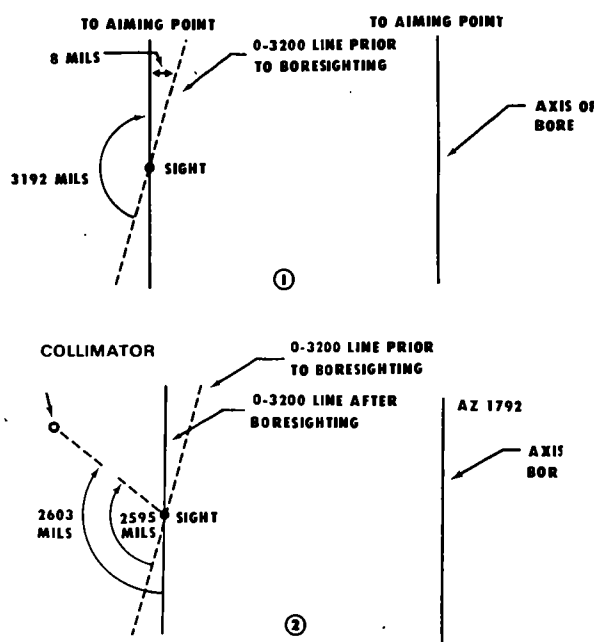
AZIMUTH 1792.

After the weapon is boresighted, a deflection of 3195 on the reset counter (2595 on the azimuth counter) will not point the tube on azimuth 1792 (②, fig 8-5).

(1) To correct the lay error caused by the base piece not being in boresight, the executive officer has two options. He can re-lay the weapon, or he can—

(a) Refer the sight to its primary aiming point (collimator) without moving the tube. The azimuth scale should read 2603 mils ($2595 + 8$).

(b) Set the counter reset scale to 3200. The weapon is now laid on the measured azimuth (1792 mils in this example) with the boresighting error corrected and with a referred deflection of 3200 mils.



★ Figure 8-5. Example of error in azimuth due to error in boresighting.

(2) If a DAP is used to boresight, the following procedure is used:

(a) Prior to measuring the azimuth (1800 mils), the executive officer notes the reading on the azimuth scale of the pantel (2595 in this example) and the piece is then laid on the DAP.

(b) During boresighting, an 8-mil error is detected (the pantel is to the right of the DAP when the azimuth scale reads 3200 mils; when the sight is referred to the DAP, the azimuth scale reads 3192 mils ($3200 - 3192 = 8$)).

(c) The weapon is boresighted.

(d) The 8-mil boresight error is applied to the previously noted azimuth scale reading of 2595 mils, yielding 2603 mils ($2595 + 8$), and is set on the azimuth scale.

(e) The piece is then laid on the aiming point (collimator) with 2603 mils on the azimuth scale.

(f) The counter reset scale is set to 3200 mils.

(g) The piece is now laid on azimuth 1792, with a referred deflection of 3200 mils.

(3) If the remainder of the battery's weapons were laid by the howitzer backlay method (para 8-14c) or if they were laid reciprocally with the base piece, they will have the base piece's boresight error in their lay. Additionally, they may have their own errors in boresight. The executive officer should:

(a) Have the remainder of the battery boresight; and

(b) Re-lay them, using the measured azimuth corrected for boresight error (1792 mils in the example above); or

(c) Have the base piece reciprocally lay the remainder of the battery after the error in its (and all the other weapons) boresight is corrected.

e. **Example 2:** Assume that in example 1 an orienting angle of 853 mils had been measured. After the 8-mil error in boresighting is determined, the corrected orienting angle is 861 mils (fig 8-6). The executive officer reports to the FDC:

ORIENTING ANGLE 861

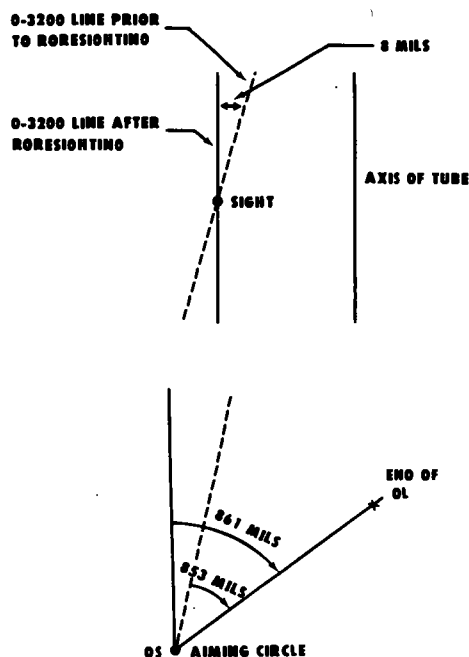


Figure 8-6. Example of error in orienting angle due to error in boresighting.

Note. It is important that the executive officer determine and apply the appropriate correction for boresighting error before making the reports in paragraphs 8-23 and 8-24. This is to preclude the FDC from having to apply corrections to the azimuth of lay more than once.

★8-28. Site by Firing (Executive Officer's High Burst)

Upon completion of an observed firing chart registration with fuze time, the command **OBSERVE HIGH BURST, MEASURE ANGLE OF SITE, 3 ROUNDS**, followed by the adjusted data, may be received from the fire direction center. This command indicates that the FDC desires the executive officer to fire three rounds and to measure and report the observed angle of site to the mean burst center of the three rounds. The executive officer—

a. Sets up the aiming circle near the base piece.

b. Has the gunner lay the instrument reciprocally.

c. Determines the angle of site necessary to make the bursts visible from the gun position.

d. Determines the quadrant elevation to be fired by adding the angle of site determined in c above to the adjusted quadrant elevation.

e. Fires three rounds, using the announced adjusted deflection and time and the quadrant elevation determined in d above.

f. Measures, with the instrument, the angle of site to each burst, and computes the mean angle of site.

g. Reports to the fire direction center the mean angle of site and the quadrant elevation fired.

★8-29. Executive Officer as an Observer in a High-Burst Registration

The executive officer may act as an observer for a high-burst registration. His instrument must be placed over a surveyed location

(battery center or orienting station) and oriented on a surveyed direction. The precise procedures for an observer in a high-burst registration are set forth in FM 6-40, *Field Artillery Cannon Gunnery*.

★8-30. Training

Training in the proper methods of determining and reporting data should be part of training personnel to lay the battery. The personnel indicated in paragraph 8-18b should receive this training. Use of a card like the one in table 8-2 will assist in remembering the procedural steps.

Table 8-2. How to Measure and Report Piece Direction

HOW TO MEASURE THE ORIENTING ANGLE		
SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	U	With the Upper motion, place the deflection reed to you by the gunner on your aiming circle.
Do this SECOND	L	With the Lower motion, sight on the howitzer panoramic telescope.
Do this LAST	U	With the Upper motion, sight on the end of the orienting line.
THE READING IS THE ORIENTING ANGLE		
TO MEASURE THE AZIMUTH OF FIRE		
SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	U	With the Upper motion, place the deflection reed to you by the gunner on your aiming circle.
Do this SECOND	L	With the Lower motion, sight on the howitzer panoramic telescope.
Do this THIRD	U	With the Upper motion, center the magnetic needle.
Do this LAST	SID	Subtract the Instrument reading (on the aiming circle) from the Declination constant.
THE RESULT IS THE AZIMUTH OF FIRE		
TO REPORT PIECE DIRECTION		
Go to the howitzer.		
Check to insure that the bubbles on the sight mount are level; if they are not, level them.		
Check the sight picture; if it is incorrect, correct it by moving the head of the panel only. DO NOT TRAVERSE THE TUBE.		
Reed and report the deflection on the panel.		



CHAPTER 9

HASTY SURVEY TECHNIQUES

Section I. HASTY SURVEY: DIRECTION

9-1. General

a. When the time and the tactical situation permit, accurate survey data will be provided by a survey section. Ideally, the battery will pull into position and will find the battery center, the orienting station (OS), and the end of the orienting line (EOL) marked. A tag on the battery center stake will give the coordinates of the position, and a tag on the OS stake will give the azimuth to the end of the orienting line (EOL). When units are moving frequently, the survey section will be hard pressed to meet all of the survey demands. In this situation, the battalion survey section can be employed in 2- to 3-man teams attached to each firing battery. These teams perform the hasty survey operations discussed in this chapter and can train key personnel to perform the operations.

b. Because this team may not be available, battery supervisors must be prepared to use the hasty survey techniques prescribed in this chapter to *provide their own survey control*. Though not as precise as the techniques used by survey personnel, these methods will serve to place the firing batteries of the battalion on a *common grid*. The direction determined by these methods will be more accurate than that determined by use of the magnetic needle in the aiming circle.

c. The key is *training*. The XO, chief of firing battery, gunnery sergeant, and other battery supervisors must be trained in these survey techniques. Hasty survey techniques must be integrated into field exercises.

d. The elements of survey control include direction, location and height.

(1) *Accurate direction* is by far the most important of these three elements of survey control. The field artillery, as an indirect fire system, must have a precise direction to any target it engages. The accuracy of this direction in the first round of every fire

mission is directly dependent on the accuracy of the azimuth of lay. Ideally, the lay of the battery would always be based on a highly accurate orienting line established by battalion surveyors. If it is based on simplified survey techniques, the battery lay, and consequently the first round of every fire mission, will be accurate in direction to approximately 2 mils or less. If, on the other hand, the battery lay is established by the grid azimuth method (use of the magnetic needle), the accuracy of lay will vary because of the various attractions affecting the magnetic needle. The error in the target area introduced by an inaccurate lay is not constant; rather, it varies directly with the range to each target that is engaged.

(2) *Accurate location* of the battery is second in order of importance. If survey techniques (normally traverse or resection) are employed to establish the battery position, a high degree of accuracy is assured. The alternative is for the battery location to be estimated by a map-spot. This error is constant from one mission to the next. If, for example, the battery's position is map-spotted 200 meters too far east, the initial rounds of each mission fired prior to registration will land 200 meters to the east of its intended point of impact (excluding all other sources of error).

(3) *Height* is the least important of the elements of survey control. If height is not established by formal survey procedures, it must be obtained through use of the contour lines on the map sheet covering the area of operations. A map-spotted height generally introduces only a minor error into the computation of site.

(4) Errors in firing due to lack of survey control can be eliminated by registration. The registration must be conducted from the battery position or an offset position located accurately in relation to the main position. In

a rapidly-moving environment, however, a registration may not be possible due to time and ammunition considerations. Against a sophisticated enemy, a registration might needlessly compromise the security of a battery position. The battery, then, must be prepared to deliver accurate fire without benefit of registration. This can be done only by taking maximum advantage of existing survey control and by improvising control through hasty survey techniques as necessary.

e. The hasty survey techniques discussed in this chapter fall into two categories: *directional control* and *determining battery (platoon) location*. Hasty survey techniques will be used to provide the most accurate direction and battery (platoon) location possible when survey is not available. The establishment of *direction* has priority.

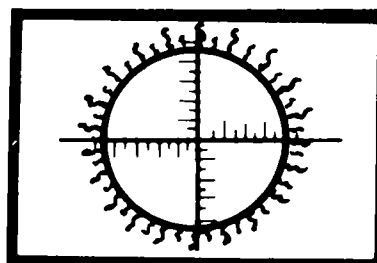
9-2. Directional Control from Simultaneous Observation

a. *Simultaneous observation* of a celestial body is the fastest and easiest method of establishing directional control by hasty survey. It provides a rapid method of transferring direction over great distances without time-consuming computations. This method is ideally suited to the needs of the artillery, since many units can be placed on common directional control in minutes. The principle behind simultaneous observation is that any celestial body is so far away that, for practical purposes, the lines of sight to it at any instant from two or more points on the surface of the earth are parallel.

b. Operators at both stations begin tracking the same celestial body with their respective instruments. As the master station operator tracks, he announces, TRACKING, TRACKING, TRACKING, TIP. The sighting is made by the flank station operator when TIP is announced. During daylight, the sun is

used for observation. At night, any predetermined celestial body may be tracked.

THE PROPER METHOD OF SIGHTING ON THE SUN IS LIKE THIS—



DO NOT OBSERVE THE SUN WITHOUT A FILTER ON THE TELESCOPE LENS.

c. *Simultaneous observation requires—*

- (1) Clear weather that will permit visibility of a celestial body.
- (2) Communications (normally radio).
- (3) Known directional control within the battalion.

d. *Procedures* for simultaneous observation are:

(1) The point having known directional control (a grid azimuth to an azimuth mark) can be occupied by survey personnel or firing battery personnel. This point becomes the *master station* in the simultaneous observation. Each position needing directional control becomes a *flank station*. The aiming circle at the flank station is set up to observe the prearranged celestial body and becomes the orienting station for the battery. The purpose of a simultaneous observation is for the master station to transfer a known azimuth to each flank station by use of a celestial body.

(2) The specific steps for the conduct of a simultaneous observation are shown.

MASTER STATION

- Step 1. Set the known azimuth value on the instrument scale and sight on the azimuth mark.
- Step 2. Track the celestial object and announce TIP; read the azimuth to the object directly from the scale and announce it to the flank station.
- Step 3. When the flank station is ready, track the object and announce TIP again and record the second azimuth.
- Step 4. Determine the clockwise angle (the check angle) between the first and second azimuth. Announce the check angle to the flank station.

The second TIP on the celestial object serves only to verify the accuracy of the orienting line. The procedures for a second TIP are not mandatory, but should be performed if the tactical situation allows.

FLANK STATION

- Step 1. Set 0.0 mils on the aiming circle with the *upper* motion.
- Step 2. Identify the predetermined celestial object. With the *lower* motion, sight on and track the object until the master station announces *TIP*.
- Step 3. Depress the telescope of the aiming circle and place the EOL squarely along the aiming circle line of sight. Record the azimuth that is announced by the master station.
- Step 4. With the *upper* motion, track the celestial object until the master station announces *TIP*.
- Step 5. Read the angle that was measured (read the horizontal scales) and copy the check angle from the master station.
- Step 6. Insure that the check angle from the master station and the reading on the horizontal scales of the aiming circle agree within ± 2 mils.
- Step 7. The azimuth recorded in step 3 is the azimuth to the EOL and is used in computing the orienting angle.

In some cases, it may be desirable to move the EOL to a more convenient location. This can be accomplished in three steps:

1. Set the grid azimuth of the orienting line on the scales of the aiming circle with the upper motion.
2. Sight on the EOL with the lower motion.
3. Using the upper motion, turn the line of sight to the desired location and direct an assistant to reposition the aiming post. The azimuth of the new orienting line is the value on the upper motion. Record the azimuth to the EOL.

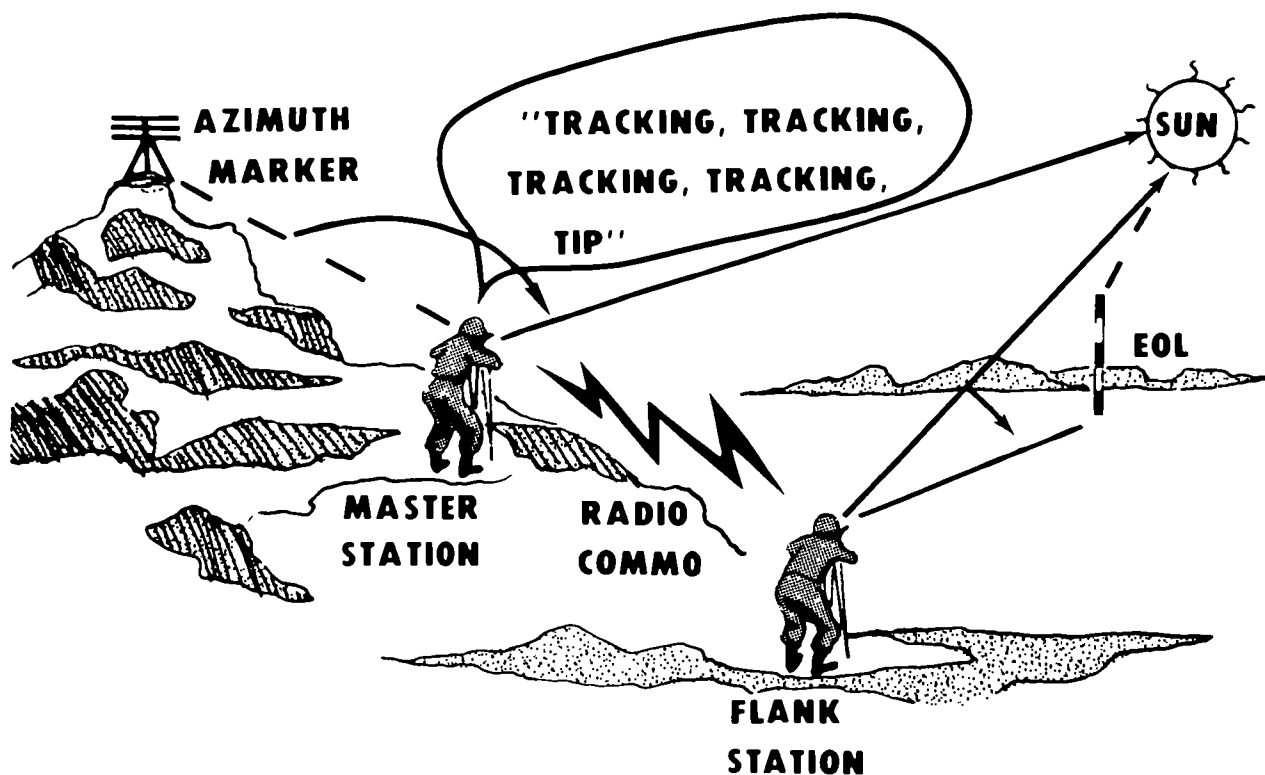


Figure 9-1. Simultaneous observation.

An example of the radio transmissions required for a simultaneous observation follows:

MASTER STATION

- 2 This is _____ ,
start tracking, out.
- 3 This is _____ ,
tracking, tracking, tracking, TIP, out.
- 4 This is _____ ,
azimuth _____
over.
- 6 This is _____ ,
tracking, tracking, tracking, TIP,
out.
- 7 This is _____ ,
check angle _____ ,
out.

FLANK STATION

- 1 _____ this is
_____, ready to observe, over.
- 5 This is _____ ,
azimuth _____ ,
ready to observe, over.

Note. If the simultaneous observation can be prearranged the FLANK station can maintain radio silence.

9-3. Directional Control from Polaris

Observation of Polaris is a second technique of establishing very accurate directional control. It is simple and fast and has the distinct advantage of requiring no radio or wire communications. Caution must be exercised, however, since the instrument operator must be thoroughly trained in finding both Polaris and the star Kochab, which are in the constellation known as the Little Dipper (Ursa Minor).

a. Polaris is one of the two brightest stars in the constellation Ursa Minor. Because it moves in a small elliptical orbit about the celestial North Pole, it is commonly referred to as the North Star. Polaris is the last star in the handle of the Little Dipper as shown in figure 9-2. Two stars in the bowl of the Big Dipper (Ursa Major) actually point toward Polaris. These stars are called The Pointers. Polaris is approximately five times the distance between The Pointers along an

imaginary line from the Big Dipper. On the opposite side of the Little Dipper is the constellation Cassiopeia, which looks like a "lazy W."

b. The second star needed to perform the observation is Kochab. Kochab is the other bright star (as bright as Polaris) in the Little Dipper. It is the front star of the bowl and is the ONLY bright star between Polaris and the Big Dipper. Of the two "front" stars in the bowl of the Little Dipper, Kochab is the brighter and the closer to Polaris. For rough orientation of the aiming circle, the operator first sets the declination constant on the scale and centers the magnetic needle. Next, from a map he determines his latitude to the nearest degree and converts it to mils by multiplying by 18. He then sets this value on the elevation scales of the aiming circle. Polaris will appear in or very close to his line of sight.

c. To establish the orienting line, the horizontal *clockwise* angle from Kochab to Polaris is measured. Then the true azimuth to

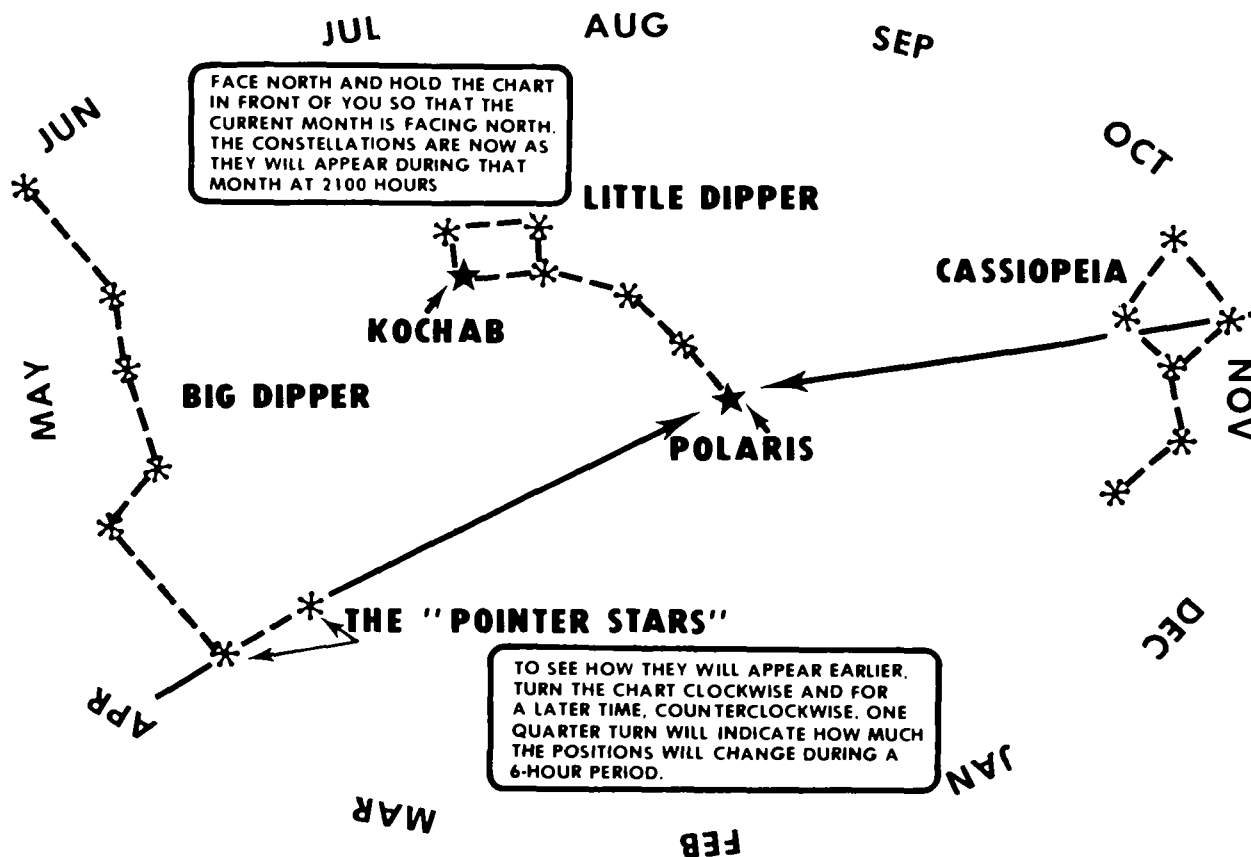


Figure 9-2. Locating Polaris.

Polaris is extracted from the appropriate table and the true azimuth is converted to grid azimuth. The steps for establishing direction by observing Polaris are:

(1) *Measuring the angle.*

(a) Set up and level the aiming circle over the selected point.

(b) Using the upper motion, set 0.0 mils on the azimuth scale.

(c) Place the vertical crosshair of the instrument on Kochab, using the LOWER motion and the elevation micrometer knob.

(d) Turn the azimuth micrometer knob (UPPER motion) so the vertical crosshair is centered on Polaris (the telescope may also have to be elevated or depressed).

(e) Read the value on the azimuth scales to the nearest mil.

(f) Depress the telescope to ground level and have an aiming post emplaced along the line of sight of the vertical crosshair. The post will serve as the end of the orienting line (EOL) and the aiming circle becomes the OS.

(2) *Extracting the true azimuth to Polaris.*

(a) Enter table 9-1, 9-2, 9-3, or 9-4

(whichever is closest to the latitude of the instrument operator).

(b) Enter the appropriate table on the left side with the value from the UPPER motion of the aiming circle (interpolate visually as necessary).

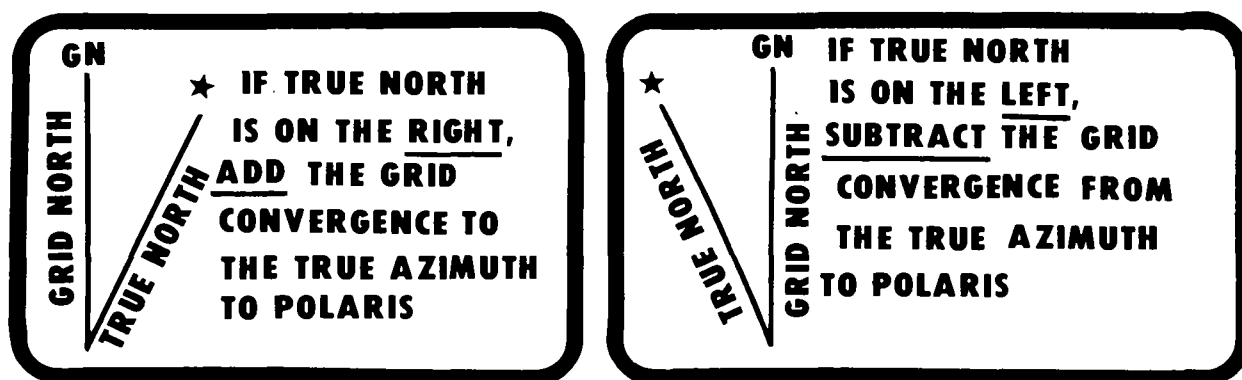
(c) Determine whether to intersect with Graph 1 or Graph 2, based on whether Kochab is above or below Polaris, as illustrated in the table. When in doubt, compare the vertical angles to the two stars.

(d) Read directly from the point of intersection to the bottom of the table and extract the true azimuth to Polaris to the nearest mil, interpolating for odd-numbered values.

(3) *Converting true to grid azimuth.*

(a) Determine the grid convergence (angle between true and grid north) in mils from the map sheet covering the area of operations.

(b) Convert true to grid azimuth as shown in figure 9-3. The grid azimuth to the EOL is now known and the battery may now be laid by the standard orienting angle method. If it is desirable to move the location of the EOL, follow the procedures listed in the note in paragraph 9-2d(2).



REMEMBER- -RIGHT-ADD, LEFT-SUBTRACT

Figure 9-3. Application of grid convergence.

Table 9-1. Determining True Azimuth, 20° North Latitude

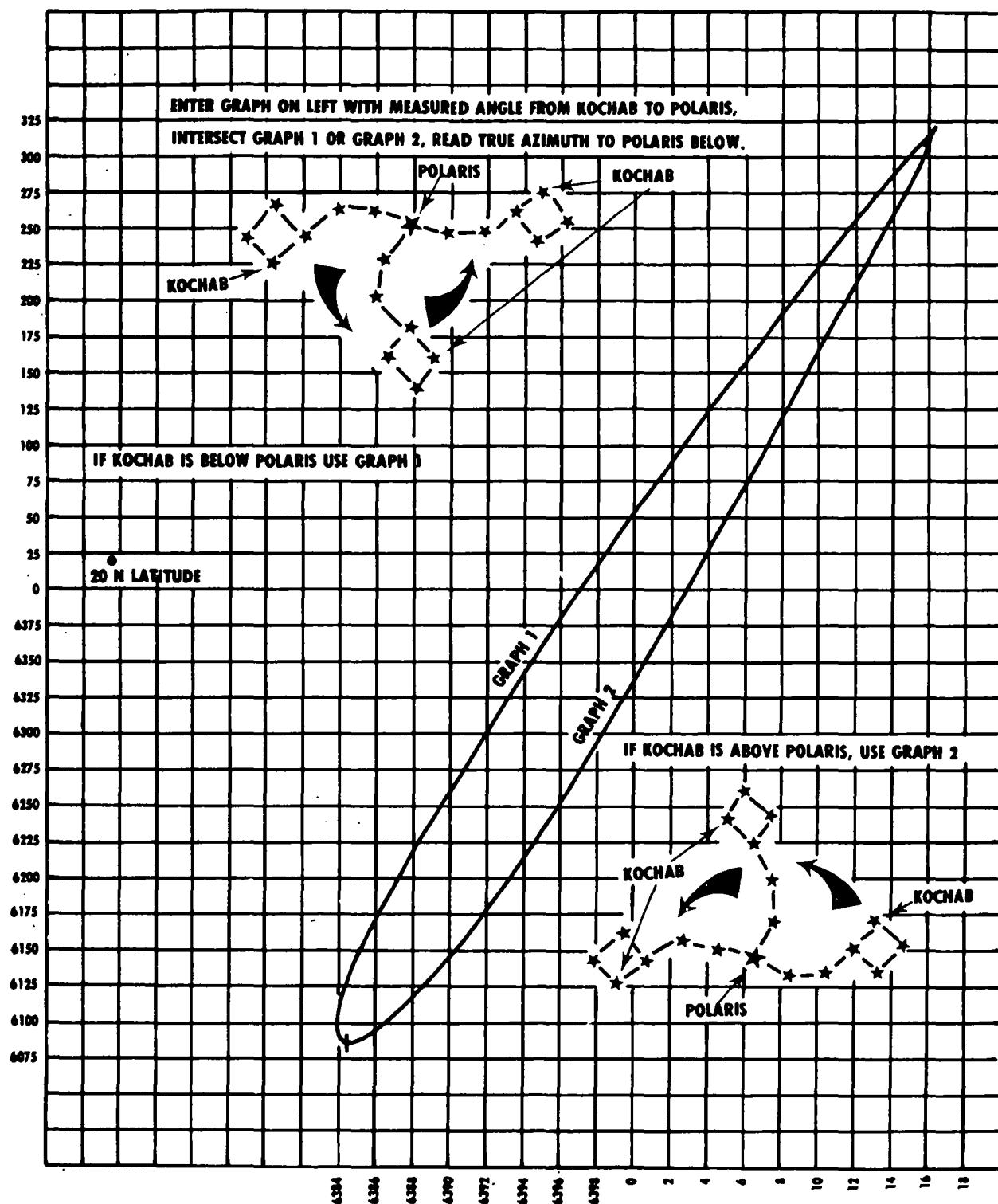


Table 9-2. Determining True Azimuth, 35° North Latitude

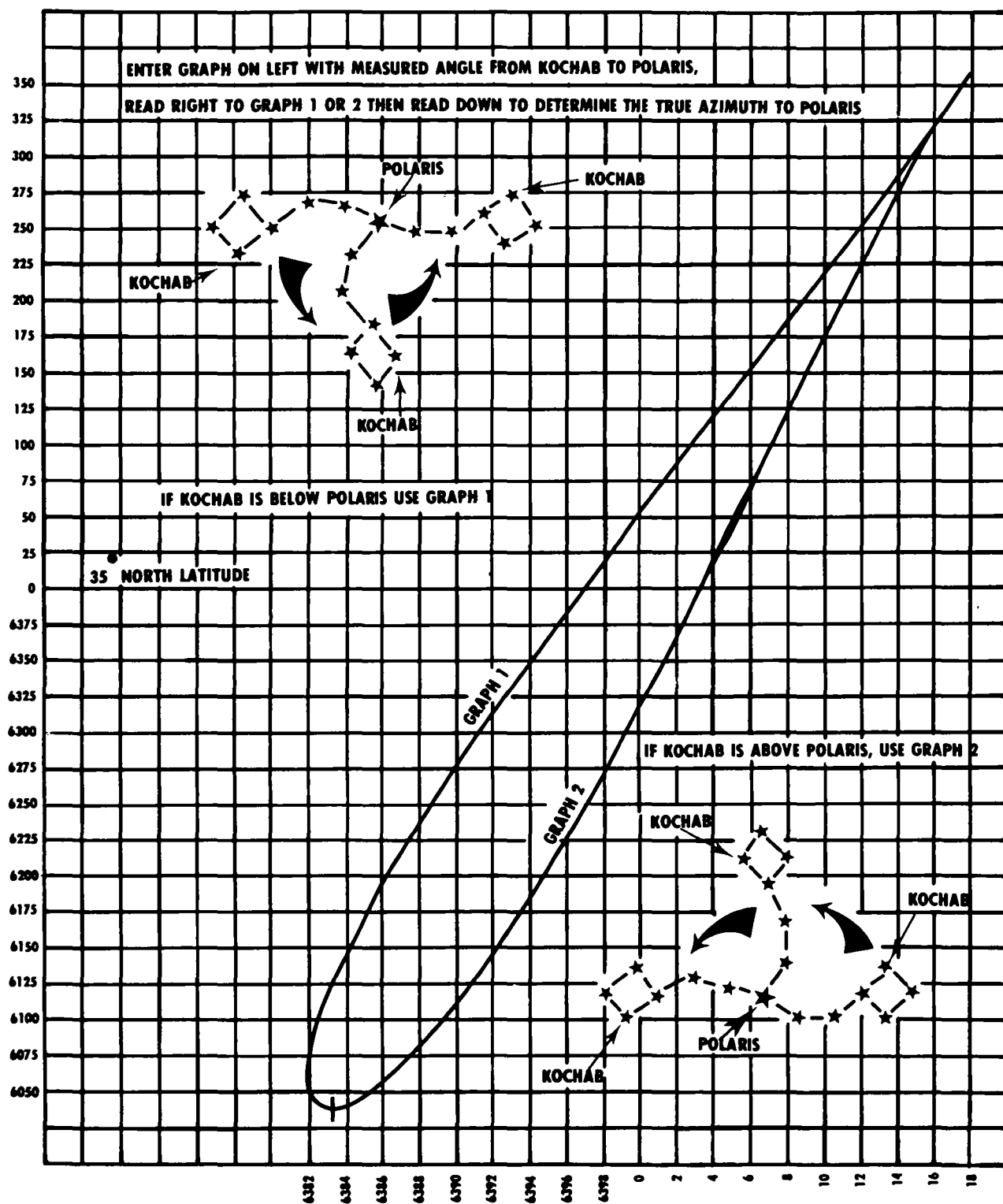


Table 9-3. Determining True Azimuth, 42° North Latitude

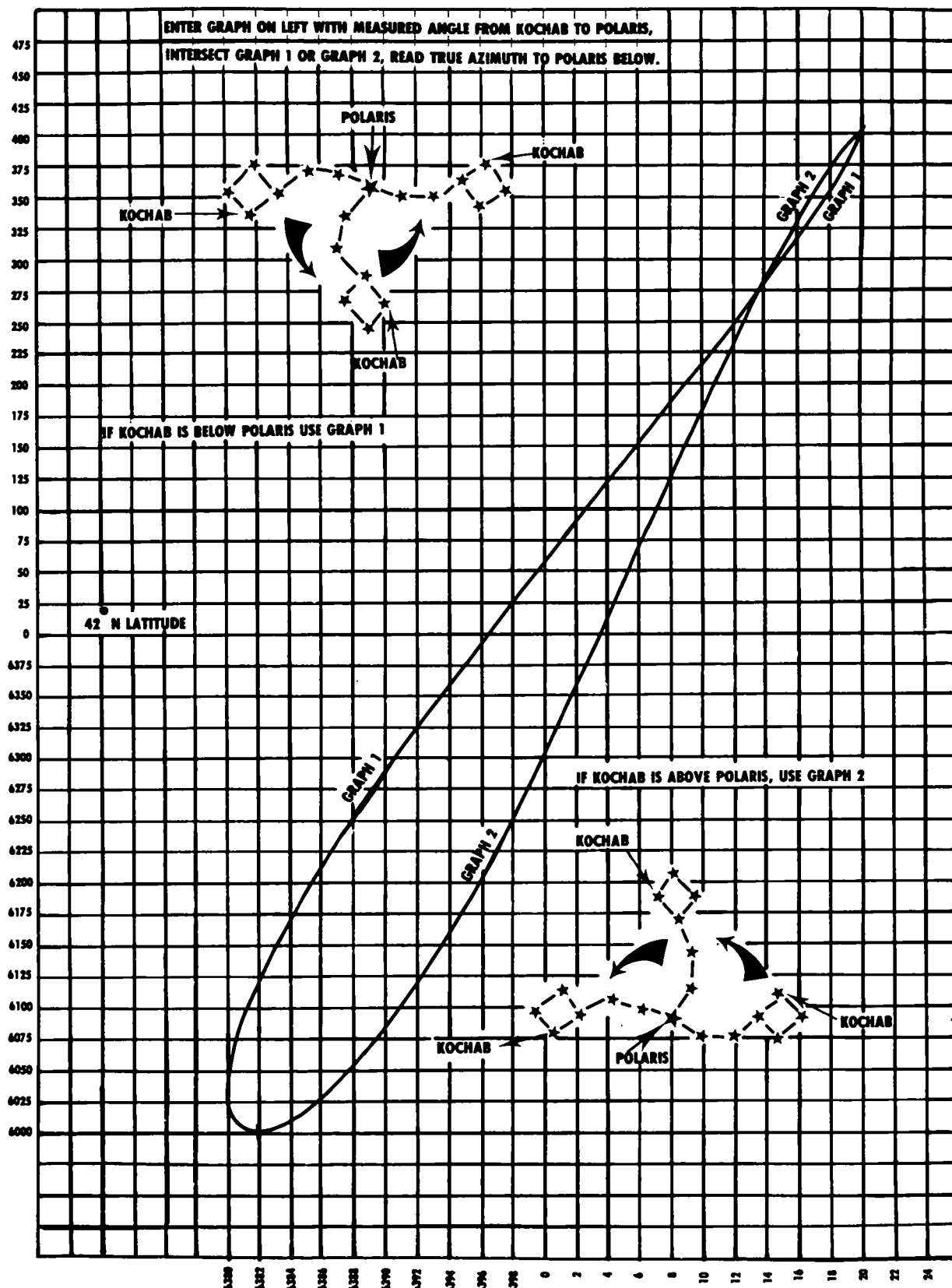
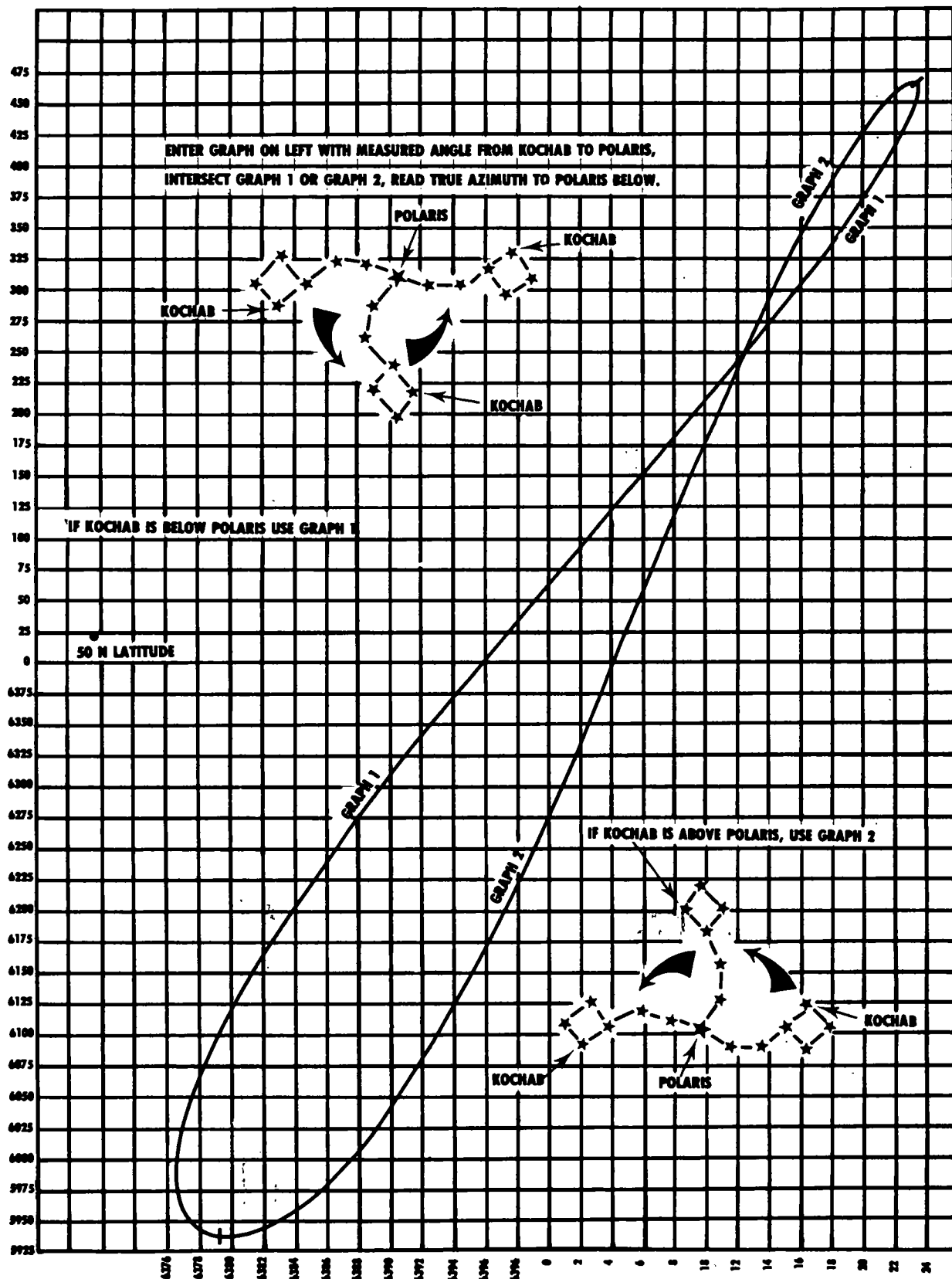


Table 9-4. Determining True Azimuth, 50° North Latitude



9-4. Directional Traverse

a. Directional traverse is a means of transferring azimuth from one point to another. It can provide common direction to each battery of a battalion or to an offset position. It will provide more accurate results than scaling an azimuth from a map or floating the needle in the compass of an aiming circle. It should be used only when conditions prohibit the use of either simultaneous observation or the Polaris method. To initiate a directional traverse, the only information required is a known azimuth from a start point to a reference point. To perform a directional traverse, the only field work required is to measure horizontal *clockwise* angles at each of the traverse stations as shown below. At the "occupied" station these angles are always measured from the "rear" station clockwise to the "forward" station. For example, in the diagram below, azimuth is required to point B. Azimuth is known at point A to an azimuth mark. By measuring the angle (called the "station angle," indicated in fig 9-4) at A, and adding this angle to the known azimuth from A to the azimuth mark, the azimuth from A to B may be found.

b. The number of stations in a directional traverse should be kept to a minimum in order to minimize loss of accuracy. The only limiting factor on the length of a traverse leg is line of sight; that is, the instrument operator must be able to see each forward and rear station (marked by a range pole or aiming stake) through the telescope of the aiming circle. The directional traverse should be planned so that the final forward station is the orienting station for the battery. The orienting line then becomes the back-azimuth of the last leg.

c. At battery level, the M2 aiming circle is used, and angles are read from the upper motion to the nearest 0.5 mil. Each angle that is determined degrades the accuracy of the initial azimuth by only 0.5 mil. The steps for conducting a directional traverse are:

- (1) Set up and level the aiming circle over the occupied station.
- (2) With the upper motion (recording), set 0.0 mil on the aiming circle.
- (3) With the lower motion (nonrecording) sight on the known reference point (rear station).

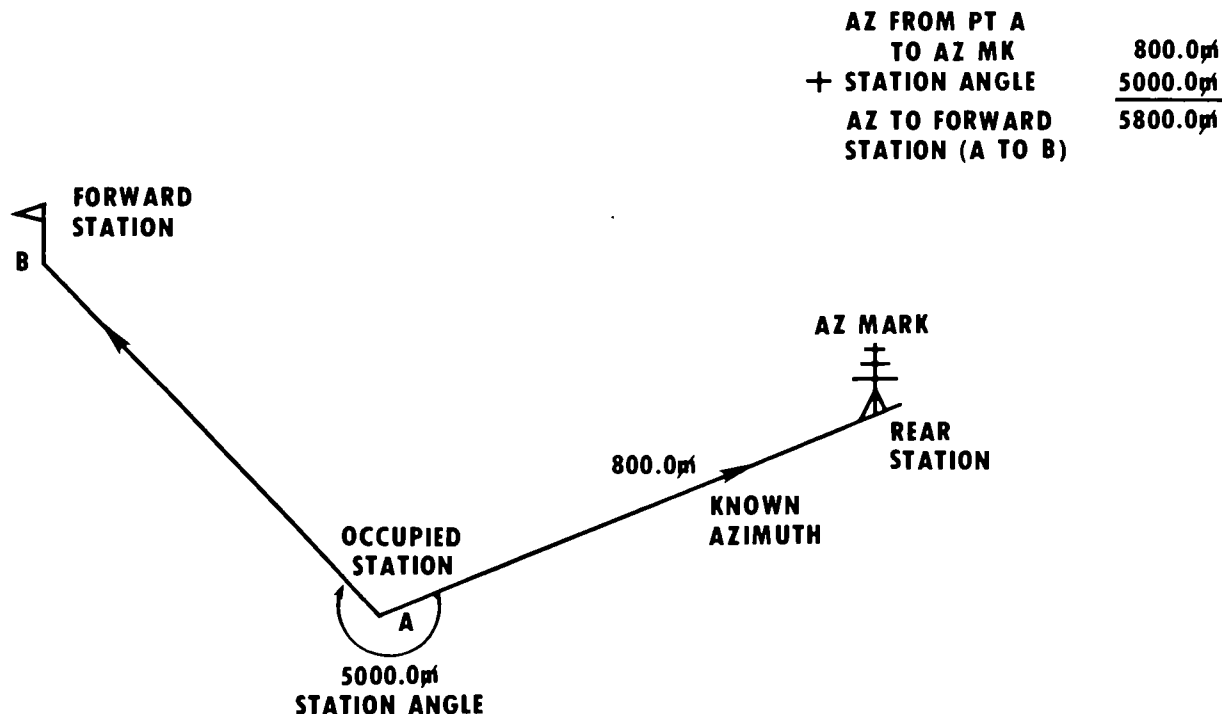


Figure 9-4. Fieldwork requirements of a directional traverse.

(4) With the upper motion (recording), measure the angle to the unknown point (forward station) and record this *first reading* on the upper motion to the nearest 0.5 mil.

(5) With this reading on the scales, sight again with the lower motion on the known reference point (rear station).

(6) With the upper motion, again measure the angle to the forward station and record the *second reading* on the upper motion to the nearest 0.5 mil.

(7) Divide the second reading by two to determine the *mean angle*. This angle, rounded to the nearest 0.1 mil if necessary, must agree with the first reading within 0.5 mil. If the first reading is in excess of 3200 mils, 6400 mils must be added to the second reading before dividing by 2. It is the *mean angle* that is used in the computation of the directional traverse.

Example 1

1st reading = 1036.0
2d reading = 2072.5
 $2072.5 \div 2 = 1036.2$
Mean angle = 1036.2

This angle is valid because it agrees with the 1st reading within 0.5 mil.

Example 2

1st reading = 3966.0
2d reading = 1533.5
 $1533.5 + 6400.0 = 7933.5$
 $7933.5 \div 2 = 3966.8$

The mean angle (3966.8) is not valid because it does not agree with the first reading within 0.5 mil; the angle must be re-measured.

Note: This procedure for measuring angles must also be used for the determination of angles in graphical resection and subtense.

d. An example of a directional traverse is shown below.

The known azimuth from A to the Az Mk is 0805.0

The mean station angles measured were

Station A	4997.5
TS-1	2248.2
TS-2	5168.8

The method of determining the azimuth from B to TS-2 is:

Known Az A to Az Mk	0805.0
plus Station $\angle$ at A	+4997.5
Az Sta A to TS-1	5802.5

(To determine back azimuth, the next step is always required)

± 3200 mil	-3200.0
Az TS-1 to Sta A	2602.5

plus station at TS-1	+2248.2
Az TS-1 to TS-2	4850.7

± 3200 mil	-3200.0
Az TS-2 to TS-1	1650.7

plus station $\angle$ at TS-2	+5168.8
(if the result of summing an Az and station $\angle$ exceeds 6400 mil— a full circle—then 6400 mil must be subtracted.)	6819.5
	- 6400.0

Az TS-2 to Sta B	0419.5
± 3200 mil (to determine back Az)	+3200.0
Az B to TS-2	3619.5
Az from OS "A" to EOL	3619.5

Additionally, a grid azimuth may be scaled from a map by placing a protractor on a known occupied position and drawing a line through a visible known point, the location of which is indicated on a map sheet. By measuring the grid azimuth of the line with a protractor, an azimuth accurate to ± 5 mils may be obtained.

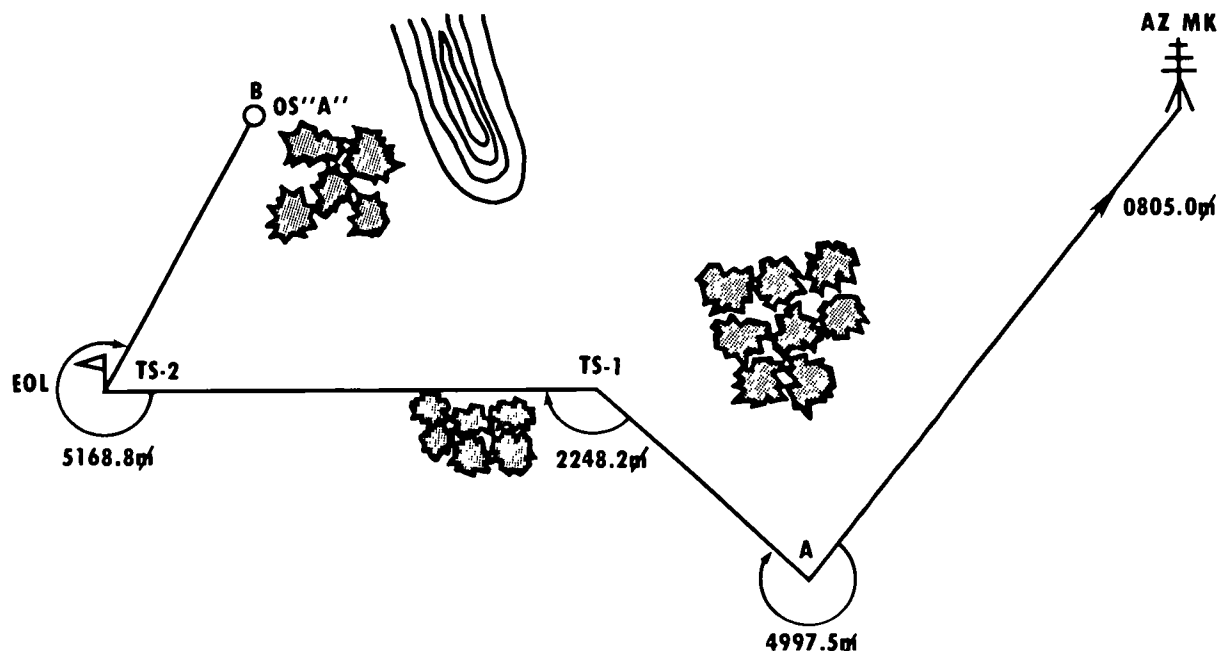


Figure 9-5. Example of a directional traverse.

Section II. HASTY SURVEY: LOCATION

9-5. Coordinates

a. In an ideal situation, the survey of each battery position is completed before arrival of the firing battery. Part of the finished survey includes a stake marking the position of battery center and tagged with its coordinates and height. The coordinates used by surveyors are not those which simply identify a point on the map sheet; rather, they are the complete UTM coordinates that reference the point within the entire grid zone. The easting of the point indicates the number of meters east (or west) that the point is from the central meridian of its grid zone. The northing of the point is the number of meters that point is north or south of the equator (a false northing is used in the southern hemisphere). These coordinates can be found on the map sheet by referencing the small numbers in the lower left-hand margin. However, there is generally no requirement to use the complete coordinates within the firing battery.

b. An example of the coordinates of surveyed battery center follows:

	EASTING	NORTHING
A Battery Center	546702.4	3836848.2

To convert this to horizontal chart data, round both the easting and northing to the nearest meter and extract the first five digits to the left of the decimal in both numbers; e.g., the grid should read 46702, (easting), 36848 (northing). This 10-digit grid (4670236848) can then be plotted as battery center by the FDC chart operators. If FADAC is used, easting and northing can each be entered with five digits to the left of the decimal and up to two digits to the right of the decimal.

For further information on the derivation and structure of the UTM grid system, see FM 21-26.

9-6. Methods of Determining Location

The firing battery has essentially two hasty survey methods available to determine coordinates of the battery center. These are *graphic resection* and *graphic traverse*.

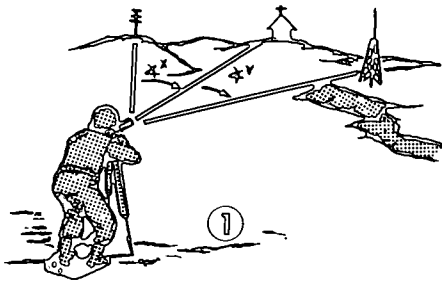
a. Graphic resection. Graphic resection is a rapid method of determining a position based on the known locations of certain visible points. The equipment needed to perform a graphic resection includes an aiming circle, map sheet, grid sheet, overlay paper, and standard FDC plotting equipment. Graphic resection may be done in one of two ways, each of which is discussed below.

(1) *Graphic resection when no azimuth control is available.*

(a) Select a location from which three distant points, which appear on a map, are visible. These points should be well defined vertical features, such as water or radio towers, trig markers, or church steeples.

(b) Measure the three clockwise angles between these points with the aiming circle. For each angle, use the standard measuring procedure outlined in paragraph 9-4c.

(c) Check that the sum of the three angles equals 6400 ± 1.5 mils. This verifies that each angle is accurate to 0.5 mil, and that the three angles together encompass the entire horizon.



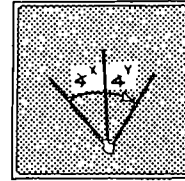
(d) Scale the coordinates of the three known points off a map (to eight digits) and transfer the plots onto a grid sheet (standard 1:25,000 firing chart). A trig list of known points may also be used, if available.

(e) Place a pin at a random point near the center of the overlay (tracing) paper. Using the RDP, draw a line from the pin hole in any direction and label it as the ray to the first of the three points. With the fan of the RDP, measure clockwise the number of mils corresponding to the angle between the first and second known points. Draw the ray to the second known point. From this ray, measure

clockwise the number of mils corresponding to the angle between the second and third known points. Draw the ray to the third point. You will note that the third angle (between the third and first known points) is now already constructed on the overlay paper, and it should be measured as a check against a large plotting error.

TRACING PAPER

②

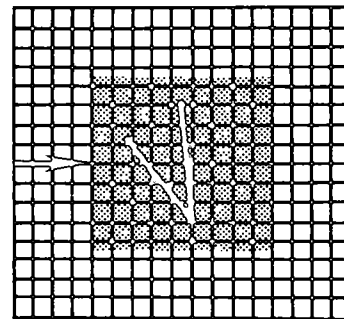


AIMING CIRCLE LOCATION

(f) Place the overlay paper on the grid sheet and position it so that the three rays pass directly through their respective points. The position of the dot now represents the location of the aiming circle on the grid sheet.

GRID SHEET

③



(2) *Graphic resection with azimuth control available.* In some cases, the aiming circle is positioned over the orienting station with a known orienting line established. If only two known points are visible from here, the resection may also be performed, using a somewhat different procedure.

(a) Measure the clockwise angles to each of the two known points from the EOL.

(b) Determine the azimuth to each known point by adding the azimuth of the orienting line to the appropriate angle measured in (a) above.

(c) Convert each of these azimuths to back azimuths by applying 3200 mils.

(d) Transfer the coordinates of the known points from the map to the grid sheet.

(e) Using the RDP, plot the back azimuths from the two known points on the grid sheet. The point of intersection of the two rays is the position of the aiming circle.

Regardless of which method of graphic resection is used, the end result is always the location of the aiming circle. If the resection was not performed from battery center, its coordinates may be estimated based on the results of the resection. The resection should be checked against the map to preclude a gross error.

b. Graphic traverse. This technique serves as a means of extending survey control from one point to another by means of angle and distance measurements. Although it establishes position as a final result, it does so by extending azimuth control as well. It may be used to provide direction and coordinates to a battery position. It is also ideal for extending survey control to an offset registration position or roving gun from a surveyed battery position. Graphic traverse is performed in a manner nearly identical to directional traverse. However, the personnel performing the traverse must measure not only the horizontal angle at each occupied station, but the distance to each forward station as well. The data needed to begin a graphic traverse includes the coordinates of a known point and the direction to an azimuth mark. The only equipment required is an aiming circle, aiming posts (for the marking of stations), and FDC equipment. The procedures for conducting a graphic traverse are outlined below.

(1) Begin the traverse at the known survey control point. Follow the procedures of directional traverse to measure the station angle from the azimuth mark (rear station) to the first forward station. Compute the azimuth of the first leg of the traverse.

(2) Measure the distance from the occupied to the forward station. The procedures for making this measurement are discussed in paragraph 9-7 below.

(3) Plot the coordinates of the survey control point (starting point) on the FDC grid sheet. Using the RDP, place an azimuth index in the general direction of traverse and draw a line representing the azimuth of the first traverse leg. Scale this line to the nearest mil. With the plotting (boxwood) scale, measure the distance of the traverse leg along the line and mark the forward point with a plotting pin. The FADAC may be used to convert these data to coordinates much more rapidly than by plotting.

(4) Continue the fieldwork for the traverse as described above. Forward stations are successively established as needed, station angles measured accordingly, and the azimuth of each leg computed as in directional traverse. The distance of each leg is plotted in the same manner as above. The traverse will appear on the grid sheet as a series of successive polar plots (fig 9-6).

(5) The traverse is planned so that the final *forward* station is the battery center or other needed position. The final *occupied* station, because it has line of sight to the forward station, can serve as the orienting station for the purpose of laying. The EOL, accordingly, is the last *rear* station in the traverse. The orienting line, then, is the *back azimuth of the second-to-last traverse leg* (fig 9-6).

9-7. Measuring Distance

When graphic traverse is used to extend survey control, the distance of each traverse leg must be measured. Because this distance is plotted on a grid sheet, it must be the *horizontal* distance along the traverse leg, not the slope distance obtained by measuring along the contour of the earth. In simplified survey operations, this horizontal distance can be easily measured in one of three ways.

a. Subtense. The subtense method is the fastest of three distance-measuring procedures and yields accuracy equivalent to that obtained with a premeasured piece of wire. Furthermore, it has the advantage of obtaining a horizontal distance indirectly; that is, it computes (rather than measures) the distance. This allows subtense to be

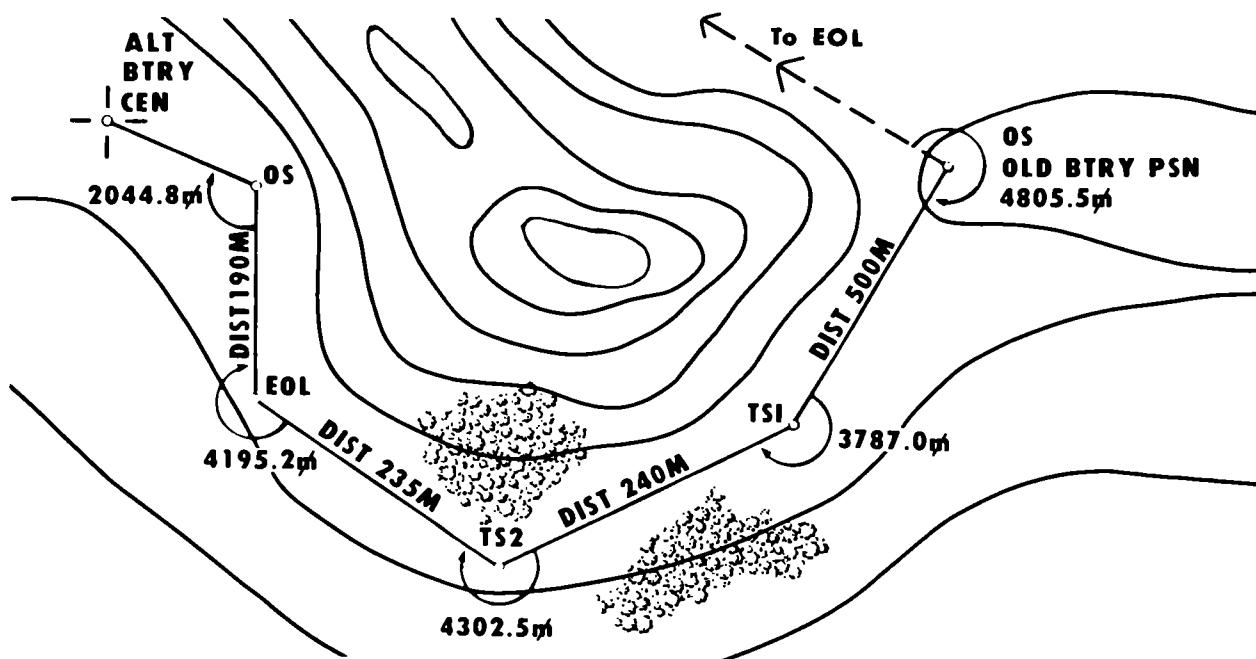


Figure 9-6. Example of a graphic traverse for an alternate battery position.

employed over terrain where obstacles, such as streams or ravines, or steep slopes may prohibit pacing or the use of wire.

(1) The principle used in determining distance by the subtense method is similar to that used in estimating distance by the mil relation. The field artillery application of the mil relation involves only estimations and is not sufficiently accurate for survey purposes, but the subtense method uses precise values with a trigonometric solution. Subtense is based on a principle of visual perspective; that is, an object of fixed length appears to decrease in size (angular value) as its distance from an observer increases.

(2) There are two procedures involved in subtense measurement.

(a) Establishing a base of known length at the forward station.

(b) Measuring the angle that the base subtends with the use of the aiming circle at the occupied station.

(3) Although the base may be of any known length, it should be either 2 meters or 60 meters (fig 9-7). The 2-meter base can be easily fabricated from aiming posts found in the battery. This base, called a 2-meter

subtense bar, must be held in the horizontal plane, bisected by the forward station and perpendicular to the line of sight of the aiming circle. Because of both line of sight problems and limitations in the trigonometric solution, the 2-meter bar will yield accurate results only for distances out to approximately 250 meters. For longer traverse legs, the larger base of 60 meters should be used. This base can be laid out rapidly at the forward station with a 60-meter length of commo wire, its ends marked by aiming stakes. As with the 2-meter bar, the

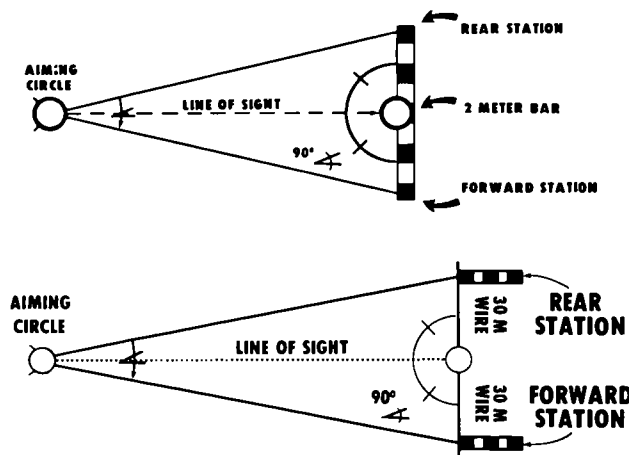


Figure 9-7. Subtense method of distance measurement.

60-meter base must be bisected by the forward station and constructed perpendicular to the line of sight of the aiming circle. The aiming circle operator, using the standard angle-measuring techniques described in paragraph 9-4c, measures the value of the subtended angle twice. The left edge of the base becomes the rear station and the right edge the forward station (fig 9-7). The mean angle is then used as the entry argument for table 9-5 or 9-6 as appropriate.

b. Pacing. A soldier who has calibrated his pace should be able to pace 100 meters to an accuracy of ± 1 meter over level ground. However, the paced distance will follow the contour of the earth. This means that in sloping or rough terrain, the determination of a horizontal distance becomes more difficult. A soldier can attempt to adjust his pace length to the degree of slope he is pacing, but his accuracy is decreased. Pacing should be used only over relatively flat terrain or when no other method is available.

c. Use of premeasured length of communications wire. A known length of commo wire (WD-1) may also be used as a means of distance measurement. This method is substantially more accurate than pacing, but requires two soldiers to hold the ends of the wire. The wire may be of any convenient length, although it is recommended that a length of 60 meters be used. The wire should be marked with tape at every meter increment; color-coded tape may

be used at every 10-meter increment to facilitate counting.

(1) The two soldiers holding the wire begin at the occupied station and measure in a straight line to the forward station. As the soldiers move along the traverse leg, they should count the number of whole wire lengths measured. By use of the meter increments marked on the wire, they measure the last partial length of wire. The distance of the leg can be determined by multiplying the number of whole wire lengths by 60 and adding the partial length.

(2) The premeasured wire method is fast and meets accuracy requirements for hasty survey techniques. However, the wire must be held horizontally to obtain a horizontal distance. This means that in rough terrain, when one end of the wire is much higher or lower than the other, it will be extremely difficult to measure long horizontal distances. In such cases, a portion of the 60-meter wire can be held horizontally and the entire distance measured using these shorter lengths (fig 9-8).

9-8. Determining Height

In the absence of height data provided by battalion surveyors, height is obtained directly from the map. Once the coordinates of the desired point have been determined by graphic resection or graphic traverse, the height of this point is taken from the map sheet and can normally be considered to be accurate to half the contour interval.

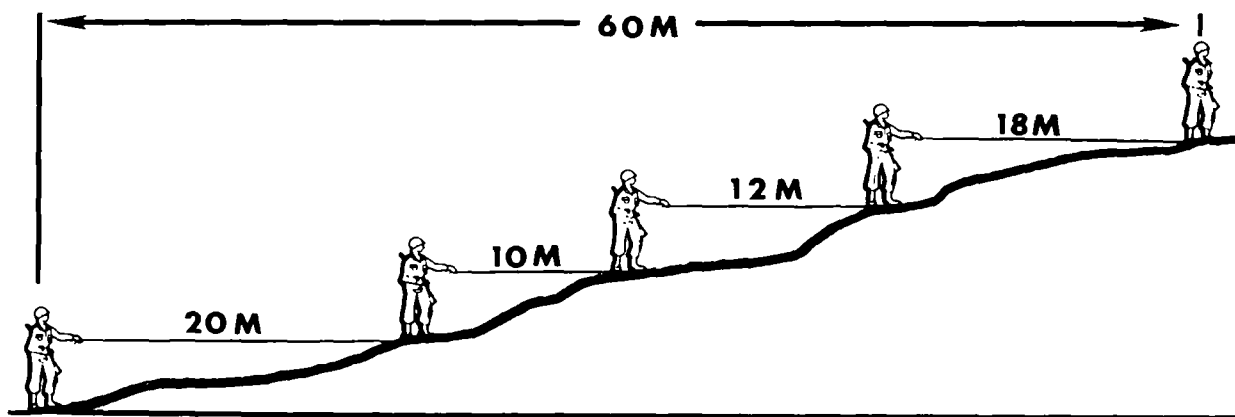


Figure 9-8. Determining distance with a premeasured length of communication wire.

Table 9-5. Subtense, 2-Meter Subtense Rod

Δ	DIST	Δ	DIST	Δ	DIST	Δ	DIST	Δ	DIST	Δ	DIST
7.0	291.03	14.0	145.51	21.0	97.01	28.0	72.75	35.0	58.20	42.0	48.50
.2	280.99	.2	142.96	.2	95.86	.2	72.11	.2	57.97	.2	48.21
.5	271.62	.5	140.49	.5	94.75	.5	71.48	.5	57.38	.5	47.93
.8	262.86	.8	137.65	.8	93.66	.8	70.85	.8	56.98	.8	47.65
8.0	254.65	15.0	135.81	22.0	92.60	29.0	70.24	36.0	56.58	43.0	47.37
.2	246.93	.2	133.58	.2	91.56	.2	69.64	.2	56.19	.2	47.10
.5	239.67	.5	131.42	.5	90.54	.5	69.05	.5	55.81	.5	46.82
.8	231.50	.8	129.34	.8	89.54	.8	68.47	.8	55.43	.8	46.56
9.0	226.35	16.0	127.32	23.0	88.57	30.0	67.90	37.0	55.05	44.0	46.29
.2	220.23	.2	125.36	.2	87.62	.2	67.34	.2	54.68	.2	46.08
.5	214.44	.5	123.46	.5	86.68	.5	66.79	.5	54.32	.5	45.77
.8	208.94	.8	121.62	.8	85.77	.8	66.24	.8	53.96	.8	45.47
10.0	203.72	17.0	119.83	24.0	84.88	31.0	65.71	38.0	53.60	45.0	45.26
.2	198.75	.2	118.09	.2	84.00	.2	65.18	.2	53.25		
.5	194.02	.5	116.41	.5	83.15	.5	64.67	.5	52.91		
.8	188.63	.8	114.77	.8	82.31	.8	64.16	.8	52.57		
11.0	185.20	18.0	113.17	25.0	81.48	32.0	63.66	39.0	52.23		
.2	181.08	.2	111.62	.2	80.68	.2	63.16	.2	51.90		
.5	177.14	.5	110.11	.5	79.89	.5	62.68	.5	51.57		
.8	173.38	.8	108.65	.8	79.11	.8	62.20	.8	51.24		
12.0	169.76	19.0	107.22	26.0	78.35	33.0	61.73	40.0	50.92		
.2	166.30	.2	105.82	.2	77.60	.2	61.26	.2	50.67		
.5	162.97	.5	104.47	.5	76.87	.5	60.81	.5	50.29		
.8	159.78	.8	103.15	.8	76.15	.8	60.36	.8	49.99		
13.0	156.70	20.0	101.86	27.0	75.45	34.0	59.91	41.0	49.68		
.2	153.75	.2	100.60	.2	74.75	.2	59.47	.2	49.38		
.5	150.90	.5	99.37	.5	74.07	.5	59.04	.5	49.08		
.8	148.16	.8	98.17	.8	73.41	.8	58.62	.8	48.79		

Table 9-6. Subtense, 60-Meter Subtense Base

α	DIST	α	DIST	α	DIST	α	DIST	α	DIST	α	DIST	α	DIST
61.0	1001.59	77.0	793.33	93.0	656.70	109.0	560.16	125.0	488.31	141.0	432.75	157.0	388.50
.2	997.50	.2	790.76	.2	654.94	.2	558.87	.2	487.33	.2	431.98	.2	387.88
.5	993.45	.5	788.21	.5	653.18	.5	557.59	.5	486.36	.5	431.22	.5	387.26
.8	989.42	.8	785.67	.8	651.44	.8	556.32	.8	485.39	.8	430.45	.8	386.65
62.0	985.43	78.0	783.15	94.0	649.70	110.0	555.06	126.0	484.42	142.0	429.69	158.0	386.03
.2	981.47	.2	780.64	.2	647.98	.2	553.79	.2	483.46	.2	428.94	.2	385.42
.5	977.54	.5	778.16	.5	646.26	.5	552.54	.5	482.51	.5	428.18	.5	384.81
.8	973.64	.8	775.68	.8	644.55	.8	551.29	.8	481.55	.8	427.43	.8	384.20
63.0	969.78	79.0	773.23	95.0	642.85	111.0	550.05	127.0	480.60	143.0	426.68	159.0	383.59
.2	965.94	.2	770.78	.2	641.16	.2	548.81	.2	479.65	.2	425.93	.2	382.99
.5	962.14	.5	768.36	.5	639.48	.5	547.57	.5	478.71	.5	425.19	.5	382.39
.8	958.36	.8	765.95	.8	637.81	.8	546.35	.8	477.77	.8	424.45	.8	381.79
64.0	954.62	80.0	763.55	96.0	636.15	112.0	545.12	128.0	476.84	144.0	423.71	160.0	381.19
.2	950.90	.2	761.17	.2	634.49	.2	543.91	.2	475.90	.2	422.97	.2	380.59
.5	947.21	.5	758.80	.5	632.85	.5	542.70	.5	474.98	.5	422.24	.5	379.99
.8	943.55	.8	756.45	.8	631.21	.8	541.49	.8	474.05	.8	421.50	.8	379.40
65.0	939.92	81.0	754.11	97.0	629.58	113.0	540.29	129.0	473.13	145.0	420.77	161.0	378.81
.2	936.32	.2	751.79	.2	627.96	.2	539.10	.2	472.21	.2	420.05	.2	378.22
.5	932.74	.5	749.48	.5	626.35	.5	537.91	.5	471.30	.5	419.32	.5	377.63
.8	929.19	.8	747.19	.8	624.74	.8	536.48	.8	470.39	.8	418.60	.8	377.04
66.0	925.67	82.0	744.91	98.0	623.15	114.0	535.54	130.0	469.48	146.0	417.88	162.0	376.46
.2	922.17	.2	742.64	.2	621.56	.2	534.37	.2	468.58	.2	417.17	.2	375.88
.5	918.70	.5	740.39	.5	619.98	.5	533.20	.5	467.68	.5	416.45	.5	375.30
.8	915.26	.8	738.15	.8	618.41	.8	532.03	.8	466.78	.8	415.74	.8	374.72
67.0	911.84	83.0	735.92	99.0	616.84	115.0	530.87	131.0	465.89	147.0	415.03	163.0	374.14
.2	908.45	.2	733.71	.2	615.29	.2	529.72	.2	465.00	.2	414.32	.2	373.57
.5	905.08	.5	731.51	.5	613.74	.5	528.57	.5	464.11	.5	413.62	.5	372.99
.8	901.74	.8	729.33	.8	612.20	.8	527.43	.8	463.23	.8	412.92	.8	372.42
68.0	898.42	84.0	727.15	100.0	610.66	116.0	526.29	132.0	462.35	148.0	412.22	164.0	371.85
.2	895.13	.2	724.99	.2	609.14	.2	525.15	.2	461.47	.2	411.52	.2	371.28
.5	891.86	.5	722.85	.5	607.62	.5	524.02	.5	460.60	.5	410.82	.5	370.71
.8	888.62	.8	720.71	.8	606.11	.8	522.90	.8	459.73	.8	410.13	.8	370.15
69.0	885.39	85.0	718.59	101.0	604.61	117.0	521.78	133.0	458.86	149.0	409.44	165.0	369.59
.2	882.19	.2	716.48	.2	603.11	.2	520.67	.2	458.00	.2	408.75	.2	369.03
.5	879.02	.5	714.38	.5	601.62	.5	519.55	.5	457.14	.5	408.07	.5	368.47
.8	875.87	.8	712.30	.8	600.14	.8	518.45	.8	456.28	.8	407.38	.8	367.91
70.0	872.73	86.0	710.22	102.0	598.67	118.0	517.35	134.0	455.43	150.0	406.70	166.0	367.35
.2	869.63	.2	708.16	.2	597.20	.2	516.25	.2	454.58	.2	406.02	.2	366.80
.5	866.54	.5	706.11	.5	595.75	.5	515.16	.5	453.73	.5	405.34	.5	366.24
.8	863.48	.8	704.08	.8	594.29	.8	514.07	.8	452.89	.8	404.67	.8	365.69
71.0	860.43	87.0	702.05	103.0	592.85	119.0	512.99	135.0	452.04	151.0	404.00	167.0	365.14
.2	857.41	.2	700.04	.2	591.41	.2	511.91	.2	451.21	.2	403.33	.2	364.59
.5	854.41	.5	698.03	.5	589.98	.5	510.84	.5	450.37	.5	402.66	.5	364.05
.8	851.43	.8	696.04	.8	588.56	.8	509.77	.8	449.54	.8	401.99	.8	363.50
72.0	848.47	88.0	694.06	104.0	587.14	120.0	508.71	136.0	448.71	152.0	401.33	168.0	362.96
.2	845.53	.2	692.09	.2	585.73	.2	507.65	.2	447.89	.2	400.67	.2	362.42
.5	842.62	.5	690.14	.5	584.32	.5	506.59	.5	447.06	.5	400.01	.5	361.88
.8	839.72	.8	688.19	.8	582.93	.8	505.54	.8	446.24	.8	399.35	.8	361.34
73.0	836.84	89.0	686.25	105.0	581.54	121.0	504.49	137.0	445.43	153.0	398.70	169.0	360.80
.2	833.98	.2	684.33	.2	580.15	.2	503.45	.2	444.61	.2	398.04	.2	360.26
.5	831.14	.5	682.42	.5	578.78	.5	502.41	.5	443.80	.5	397.39	.5	359.73
.8	828.32	.8	680.51	.8	577.41	.8	501.38	.8	442.99	.8	396.74	.8	359.20
74.0	825.52	90.0	678.62	106.0	576.04	122.0	500.35	138.0	442.19	154.0	396.10	170.0	358.67
.2	822.74	.2	676.74	.2	574.68	.2	499.32	.2	441.39	.2	395.45	.2	358.14
.5	819.98	.5	674.87	.5	573.33	.5	498.30	.5	440.59	.5	394.81	.5	357.61
.8	817.23	.8	673.00	.8	571.99	.8	497.28	.8	439.79	.8	394.17	.8	357.09
75.0	814.51	91.0	671.00	107.0	570.65	123.0	496.27	139.0	439.00	155.0	393.53	171.0	356.56
.2	811.80	.2	669.31	.2	569.31	.2	495.26	.2	438.21	.2	392.90	.2	356.04
.5	809.11	.5	667.48	.5	567.99	.5	494.26	.5	437.42	.5	392.26	.5	355.56
.8	806.43	.8	665.66	.8	566.67	.8	493.26	.8	436.63	.8	391.63	.8	355.00
76.0	803.78	92.0	663.85	108.0	565.35	124.0	492.26	140.0	435.85	156.0	391.00	172.0	354.48
.2	801.14	.2	662.05	.2	564.05	.2	491.27	.2	435.07	.2	390.37	.2	353.96
.5	798.52	.5	660.25	.5	562.74	.5	490.28	.5	434.30	.5	389.75	.5	353.45
.8	795.92	.8	658.47	.8	561.45	.8	489.29	.8	433.52	.8	389.12	.8	352.93

Table 9-6. Subtense, 60-Meter Subtense Base—continued

Δ	DIST	Δ	DIST	Δ	DIST	Δ	DIST	Δ	DIST	Δ	DIST	Δ	DIST
173 0	352.42	181.0	336.77	189 0	322.43	197 0	309.26	205 0	297.12	213 0	285.88	221 0	275.46
2	351.91	2	336.30	.2	322.01	.2	308.87	2	296.75	2	285.54	2	275.14
5	351.40	.5	335.77	5	321.58	5	308.48	5	296.39	5	285.21	5	274.83
8	350.89	.8	335.37	.8	321.15	8	308.08	8	296.03	.8	284.87	8	274.52
174.0	350.38	182.0	334.91	190 0	320.73	198.0	307.69	206 0	295.67	214 0	284.54	222 0	274.20
2	349.88	2	334.44	2	320.30	.2	307.30	.2	295.30	2	284.20	223.0	272.97
5	349.38	5	333.98	5	319.88	5	306.91	5	294.94	5	283.87	224 0	271.74
8	348.87	8	333.52	8	319.46	8	306.52	8	294.59	8	283.53	225.0	270.52
175 0	348.37	183 0	333.07	191 0	319.04	199 0	306.14	207 0	294.23	215 0	283.20	226 0	269.31
2	347.87	2	332.61	2	318.62	2	305.75	2	293.87	2	282.87	227 0	268.12
5	347.37	5	332.15	5	318.20	5	305.36	5	293.51	5	282.54	228 0	266.93
8	346.88	8	331.70	8	317.78	.8	304.98	8	293.16	8	282.21	229.0	265.75
176 0	346.38	184.0	331.25	192 0	317.37	200 0	304.60	208 0	292.80	216.0	281.88	230 0	264.59
2	345.89	.2	330.79	2	316.95	2	304.21	.2	292.45	2	281.55	231 0	263.43
5	345.40	5	330.34	5	316.54	5	303.83	5	292.10	.5	281.33	232.0	262.29
8	344.91	.8	329.89	8	316.12	.8	303.45	8	291.74	8	280.90	233 0	261.15
177 0	344.42	185 0	329.45	193 0	315.71	201 0	303.07	209 0	291.39	217.0	280.57	234.0	260.03
2	343.93	2	329.00	2	315.30	2	302.69	2	291.04	2	280.25	235 0	258.91
5	343.44	.5	328.55	.5	314.89	5	302.31	5	290.69	.5	279.92	236 0	257.80
.8	342.96	8	328.11	8	314.48	8	301.95	8	290.34	8	279.60	237.0	256.71
178 0	342.47	186 0	327.66	194 0	314.08	202 0	301.56	210 0	289.99	218.0	279.28	238.0	255.62
2	341.99	2	327.22	2	313.67	2	301.18	2	289.65	2	278.95	239.0	254.54
.5	341.55	.5	326.78	5	313.26	5	300.81	5	289.30	.5	278.63	240 0	253.47
.8	341.03	8	326.34	8	312.86	8	300.44	8	288.96	.8	278.31	241 0	252.41
179 0	340.55	187.0	325.90	195 0	312.46	203.0	300.06	211 0	288.61	219.0	277.99	242.0	251.35
2	340.07	2	325.46	.2	312.05	.2	299.69	2	288.27	.2	277.67	243.0	250.31
.5	339.59	5	325.03	5	311.65	5	299.32	5	287.92	.5	277.35	244 0	249.27
8	339.12	.8	324.59	8	311.25	.8	298.95	8	287.58	.8	277.03	245.0	248.25
												246.0	247.23
180.0	338.65	188 0	324.16	196 0	310.85	204 0	298.58	212 0	287.24	220.0	276.72		
.2	338.17	.2	323.73	.2	310.45	2	298.22	2	286.90	2	276.40		
5	337.70	.5	323.29	5	310.06	5	297.85	5	286.56	.5	276.08		
.8	337.23	.8	322.86	8	309.66	.8	297.48	8	286.22	.8	275.77		

CHAPTER 10

EXECUTIVE OFFICER'S MINIMUM QUADRANT ELEVATION

★10-1. General

In training and in combat we must insure that artillery fire lands on the intended target—that it does not hit a crest between the guns and the target. The XO is responsible for determining the lowest quadrant elevation that can be safely fired from his battery position and that will insure that projectiles clear all crests visible from the battery position. Also, the FDC must insure that rounds clear intermediate crests not visible from the battery area. The computation procedures in this chapter can be used for both.

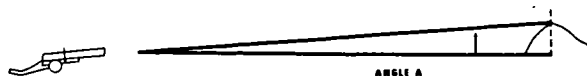
★10-2. Elements of Computation

The executive officer's minimum quadrant elevation (XO's min QE) rapid fire tables (app F), which meet required accuracies, should be used for computing executive officer's minimum quadrant elevation whenever possible. This procedure is much quicker than manual computations. An explanation of the computation of min QE with the rapid fire tables is on page F-1. The XO, however, *must* be familiar with the elements that make up this computation and how they are determined. Step-by-step procedures for computing min QE are in this chapter. They are more accurate than the rapid fire tables (although slower to compute) and may be used if desired. However, these procedures must be used instead of the rapid fire tables if the sum of the vertical angle and the complementary angle of site is greater than 300 mils. These are the elements that make up the computation.

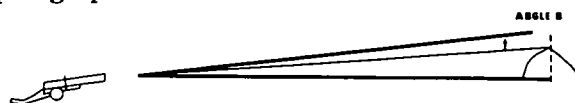
a. Piece-to-crest range (PCR) is the horizontal distance between the piece and the crest, expressed to the nearest 100 meters. Procedures for measurement are discussed in paragraph 10-4.



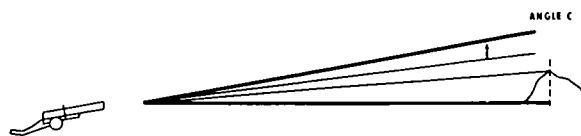
b. Angle *a* is the greatest angle of site to crest measured by all weapons (para 10-3).



c. Angle *b* is the vertical angle corresponding to the required vertical clearance for friendly elements. For quick, time, and unarmed proximity (VT) fuzes, a vertical clearance of 5 meters is used. For armed VT fuzes, see paragraph 10-8.



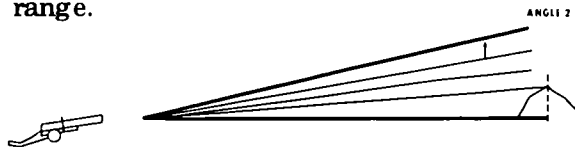
d. Angle *c* is the complementary angle of site (comp site). It is the comp site factor (from table G of the tabular firing tables) for the appropriate charge at the piece-to-crest range multiplied by the sum of angles *a* and *b*.



e. Angle 1, site, is the sum of angles *a*, *b*, and *c*.

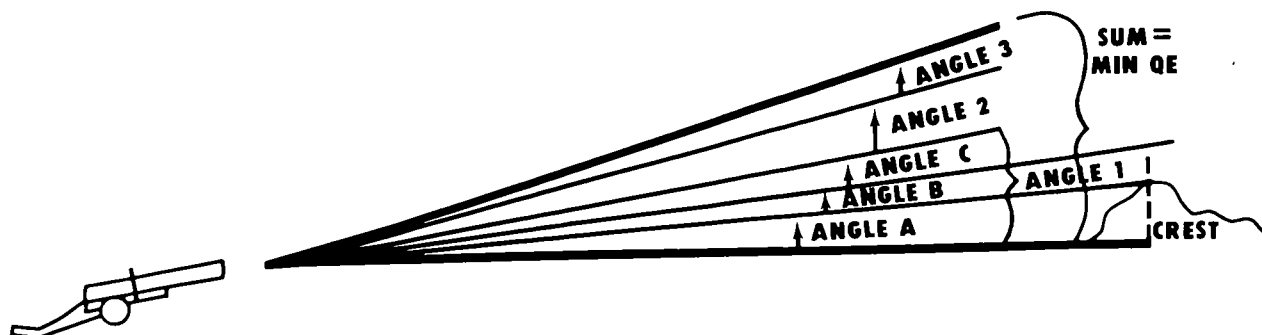


f. Angle 2 is the elevation for the appropriate charge corresponding to the piece-to-crest range.



g. Angle 3 is a safety factor equivalent to the value of 2 forks or 8 probable errors (from table F of the tabular firing tables) for the appropriate charge at the piece-to-crest range.

h. The sum of angles 1, 2, and 3 is the executive officer's minimum quadrant elevation.



★10-3. Measuring Angle of Site to Crest

As soon as his piece is laid and his primary aiming point is established, the chief of section measures the angle of site to the crest and reports it to the XO. To measure the angle of site to crest, the chief of section, sighting along the lowest element of the bore, has the tube traversed across the probable field of fire and has the tube elevated until the line of sight clears the crest at the highest point. He then centers all bubbles on the elevation mount and reads the angle of site to the crest from the elevation counter. This angle also may be measured with a gunner's quadrant placed on the quadrant seats. This angle of site is reported to the XO.

★10-4. Measuring Piece-to-Crest Range

The most commonly used methods of measuring piece-to-crest range are:

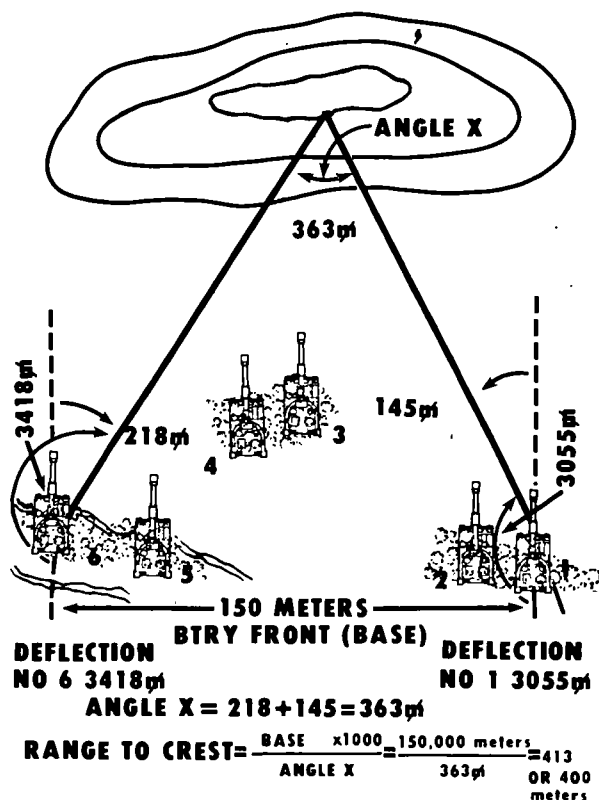
a. Mil relation. The mil relation is a particularly good method when the tactical situation permits its use. The mil relation method involves the use of the panoramic telescopes of the flank pieces, one aiming circle and one panoramic telescope, or two aiming circles. Usually, it is the most practical to use the panoramic telescopes of the flank pieces. For example, the battery has been laid parallel and the distance between flank pieces is 150 meters (fig 10-1). The steps for the mil relation method are—

(1) The gunners of the flank pieces refer to exactly the same point on the crest.

(2) Each of the flank gunners announces the deflection to the point on the crest from his piece.

(3) The apex angle (angle X) is determined from these two deflections as indicated in figure 10-1.

(4) The range in meters to the crest is determined by dividing the battery front in meters times 1,000 by the apex angle in mils. The base may be measured by pacing or by subtense if the flank pieces are intervisible. See chapter 9 for details on the use of subtense.



★ Figure 10-1. Determining piece-to-crest range by use of panoramic telescopes

b. Taping is an accurate method; however, it is time consuming and is used only when time and terrain permit.

c. *Map measurement* is a fast, accurate method that is not affected by adverse terrain features. The chart operator plots the location of the position area, determines the highest point of the crest, and measures the distance with the appropriate scale.

d. *Pacing* is a time-consuming method, dependent on the distance to the crest and the accessibility of the crest.

e. *Estimation* may be used when more accurate means are not feasible.

★10-5. Computation for Fuzes Other than Armed VT

a. The XO performs the computations indicated in this section if the sum of angles a and b exceeds 300 mils or if the rapid fire tables are not available. All angles are determined and expressed to the next higher whole mil. The following is an example of this computation. The range to crest is 1100 meters; the greatest angle of site to crest reported is +16 mils. The weapon is the 155-mm howitzer M109A1, and charge 3 green bag will be fired. The XO—

(1) Selects and records the greatest angle of site (angle a) reported by the chiefs of section. Angle a = +16 mils.

(2) Determines the value in mils of angle b, the vertical clearance angle. He uses the GST to divide the vertical clearance in meters (5 meters) by the piece-to-crest range in thousands (1.1). This value, read under the M gagepoint, is 4.6, which is *expressed to the next higher whole mil*. Angle b = +5 mils.

(3) Determines angle c (comp site) by multiplying the comp site factor corresponding to the piece-to-crest range (or the next higher listed range in table G of the TFT if that range is not listed) by the sum of angles a and b. Angle a + angle b = 21. The comp site factor corresponding to 1500 meters (range 1100 is not listed in table G) is +0.010. Therefore $+21 \times 0.010 = +0.210$. Once a value for comp site has been determined, it must be *expressed to the next higher whole mil*. Angle c = +1 mil.

(4) Determines angle 1 (site) by adding together angles a, b, and c. Angle 1 = +22 mils.

(5) Determines elevation for the piece-to-crest range (angle 2). If this value is not a whole number, it is *expressed to the next, higher whole mil* (73.4 expressed to 74). Angle 2 = +74 mils.

(6) Determines the value of 2 forks (table F of the TFT) at piece-to-crest range (angle 3). 2 forks = +2 mils.

★ (7) Adds angles 1, 2, and 3 to determine the executive officer's minimum quadrant elevation.

$$22 + 74 + 2 = 98 \text{ mils}$$

b. A single narrow obstruction, such as a tree, that will mask only one piece at a time is not considered in computing minimum quadrant elevation. If a piece cannot be fired safely, it is called out of action. If the XO does not want to call the piece out of action, he may have the piece moved so that it can be fired safely or he may direct that the mask (obstruction) be removed.

10-6. Computation for VT Fuzes (Low-Angle Fire)

a. The method of computing executive officer's minimum quadrant elevation for firing a projectile fuze with an M513, M514, or M728 fuze depends on the method in which the fuze is employed.

★ b. The proximity (VT) fuze is designed to arm 3 seconds prior to the time set on the fuze; however, some VT fuzes have armed as early as 5.5 seconds prior to the time set on the fuze. Because of the probability of premature arming, a safety factor of 5.5 seconds must be added to the time of flight to the point where arming is permitted. Since time on the setting ring is set to the whole second, the time determined is rounded up to the whole second, and this is the minimum safe time. A VT fuze is designed so that it will not arm earlier than 2 seconds time of flight, making it a boresight fuze.

c. In *noncombat* situations the XO determines the minimum safe time by adding 5.5 seconds to the time of flight to the minimum range line as shown on the safety card. The minimum quadrant elevation

determined by the XO for fuzes quick and time is also valid for fuze VT, because firing the VT fuze at a fuze setting less than the minimum safe time is not authorized.

d. In *combat* situations the XO determines the minimum safe time and minimum quadrant elevation at the piece-to-crest range or the minimum arming range, *whichever is greater*.

e. When the projectile is to be fired with the VT fuze set at a time *less than the minimum safe time*, allowance must be made for vertical clearance of friendly elements. Vertical crest clearances for M513 and M514 VT fuzes fired over ordinary terrain are shown below.

Table 10-1. Vertical Clearance

WEAPON	VERTICAL CLEARANCE
105-mm HOWITZER	80 METERS
155-mm HOWITZER	100 METERS
8-INCH HOWITZER	150 METERS

★ f. For the M728 fuze the vertical clearance is *70 meters* for all calibers. If the projectile is to be fired over marshy or wet terrain, the average height of burst will increase and, therefore, the vertical clearance shown in table 10-1 should be increased by 50 percent. If the projectile is to be fired over water, snow, or ice, the vertical clearance shown in table 10-1 should be increased by 100 percent.

g. The XO must determine the minimum arming range before computing minimum quadrant elevation for firing a projectile with a VT fuze.

(1) He converts the minimum arming time, 2 seconds time of flight, to a minimum arming range. Because this range is directly affected by muzzle velocity, it varies for different weapons and charges. After this range has been determined, he compares it with the piece-to-crest range and uses the *greater* of the two in computing the minimum

safe time and minimum quadrant elevation.

(2) To determine the minimum arming range, he enters the firing tables for the particular charge(s) and weapon system, locates the time of flight of 2 seconds (table F, column 7), and reads the range (column 1) corresponding to the minimum arming time. If the exact time of flight of 2 seconds is not listed, he uses the range corresponding to the first time of flight *greater* than 2 seconds.

(3) To determine the minimum safe time, he adds 5.5 seconds to the time of flight corresponding to the range determined above. If the value is not a whole second, he expresses it up to the next higher whole second.

★ h. The executive officer's min QE for fuze VT, when a fuze setting less than the minimum safe time is fired, is based on piece-to-crest range or minimum arming time range, **WHICHEVER IS GREATER**.

10-7. Computation Based on Piece-to-Crest Range

If the piece-to-crest range is greater than the minimum arming time range (fig 10-2), the XO determines and reports the minimum quadrant elevation for the crest based on the piece-to-crest range. For example—

The howitzers are 155-mm M109A1 and charge 4 green bag is to be fired. The greatest angle of site reported by chiefs of section is 16 mils, and the piece-to-crest range is 1700 meters. The XO computes the minimum quadrant elevation as follows:

a. **ANGLE a:** Select the greatest angle of site to the crest reported by the chiefs of section +16 mils.

b. **ANGLE b:** Assuming the crest is occupied by friendly troops, add the value in mils of a height of 100 meters at the piece-to-crest range of 1700 meters (100/1.7). +60 mils.

c. **ANGLE c:** Add comp site for piece-to-crest range of 1700 meters to the sum of angle a and angle b. (Column 12, table G, charge 4 GB, FT 155-AM-1, range 2000 meters gives a comp site factor of 0.010.) (16 + 60 = 76 x 0.010 = +0.760) +1 mil.

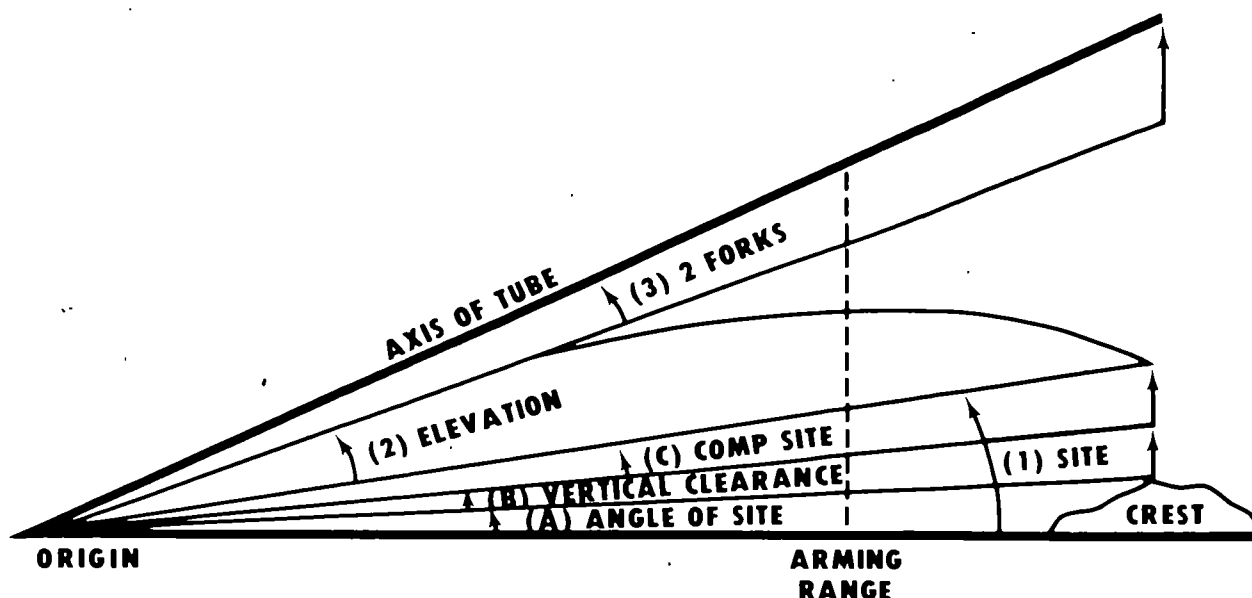


Figure 10-2. Piece-crest range greater than minimum arming range.

d. **ANGLE 1:** Determine site to crest (sum of angles a, b, and c). $(16 + 60 + 1 = +77)$ +77 mils.

e. **ANGLE 2:** Determine elevation for the piece-to-crest range. $(87.7 = 88)$ +88 mils.

f. **ANGLE 3:** Add 2 forks at the piece-to-crest range +2 mils.

g. **TOTAL:**+167 mils.

h. Minimum safe time is $5.5 + 5.5 = 11.0$
..... 11.0 seconds.

i. The XO reports to the fire direction center

**MINIMUM QUADRANT ELEVATION,
FUZE VT, CHARGE 4 GREEN BAG, 167,
MINIMUM SAFE TIME 11.0 SECONDS.**

With the 2-second arming time range, all the area between the arming range and the crest is made safe by the minimum quadrant elevation computed for the crest.

★10-8. Computation of Executive Officer's Minimum Quadrant Elevation Based on Minimum Arming Range

If the piece-to-crest range is less than the minimum arming range (fig 10-3) the XO uses the minimum arming range and the angle of site to the crest at arming range in computing

the minimum quadrant elevation. Since the XO cannot observe the terrain beyond the crest, he must assume that the angle of site at piece-to-crest range is also applicable at arming time range. He must use it in conjunction with the other factors, which are determined at arming time range, in computing the minimum quadrant elevation. After the XO determines the minimum quadrant elevation in this manner and reports it to the FDC, the battery FDC considers the need to correct the minimum quadrant elevation on the basis of the range and altitude to the highest crest not visible to the XO and short of minimum arming time range. The XO computes minimum quadrant elevations on the basis of crests visible to him or minimum arming time range. Therefore, the battery FDC must examine the best available maps to determine crests not visible to the XO. Using this information the battery FDC may compute a new minimum quadrant elevation that is different from that reported by the XO; however, the new minimum quadrant elevation can never be less than the minimum quadrant elevation for fuze M557 to the visible crest. For example—

The howitzers are 155-mm M109A1s and charge 5 green bag is to be fired. The piece-to-crest range is 500 meters, the arming time range is 800 meters, and the greatest angle of site reported is +16 mils. The XO computes the

following minimum quadrant elevation:

a. **ANGLE a:** Select the greatest angle of site to the crest reported +16 mils.

b. **ANGLE b:** Add the value in mils of a 100-meter clearance at arming time range (100/0.8) +128.

c. **ANGLE c:** Add comp site for arming time range to the sum of angle a and angle b (column 12, table G, charge 5GB, FT 155-AM-1). Since range 800 is not listed, enter at range 1,000 meters and obtain a comp site of 0.001 ($16 + 128 = +144 \times 0.001 = 0.144$) +1 mil.

d. **ANGLE 1:** Determine site to crest (sum of angles a, b, and c, or $16 + 128 + 1 = 145$) +145 mils.

e. **ANGLE 2:** Determine elevation for arming time range +31 mils.

f. **ANGLE 3:** Add 2 forks at arming time range +2 mils.

g. **TOTAL:** +178 mils.

h. Minimum safe time is $2.2 + 5.5 = 7.7$.
..... 8.0 seconds.

If the fuze setting to be fired is **EQUAL TO or GREATER THAN** the minimum safe time, the minimum QE determined for fuzes quick and time applies. If the fuze setting to be fired is **LESS THAN** the minimum safe time, the minimum QE determined for **ARMED VT** applies.

The XO reports to the fire direction center:

★ **EXECUTIVE OFFICER'S MIN QE,
FUZE VT, CHARGE 5 GREEN BAG
178, MINIMUM SAFE TIME
8.0 SECONDS.**

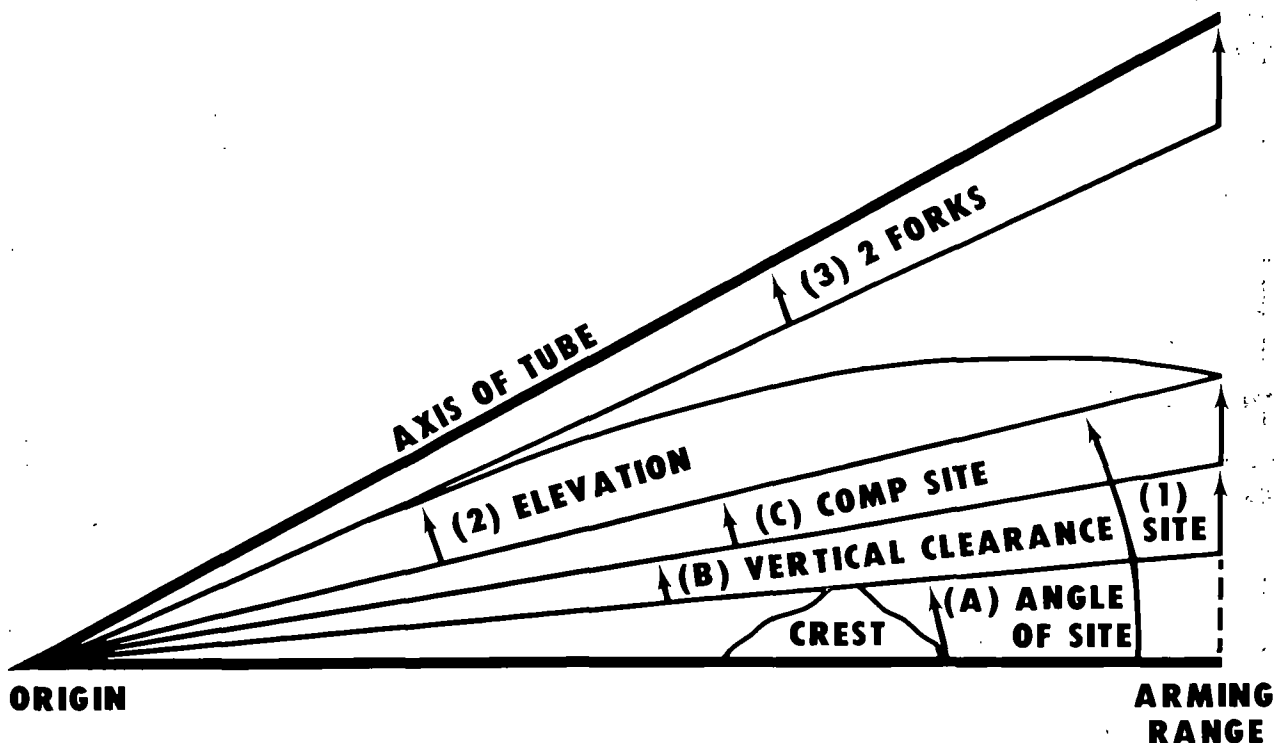


Figure 10-3. Piece-crest range less than minimum arming range.

Table 10-2 is a recapitulation of the steps for computing minimum quadrant elevation. It should be used as a reference by the XO and in training individuals to compute executive officer's minimum quadrant elevation.

★ Table 10-2. Computation of Executive Officer's Minimum Quadrant Elevation

ELEMENTS OF COMPUTATION	HOW TO DO THE COMPUTATION		
	Fuze PD, fuze MTSQ, or fuze VT with a fuze setting equal to or greater than minimum safe time.	Fuze VT with a fuze setting less than minimum safe time	
		PC range is greater than minimum arming range.	Minimum arming range is greater than PC range.
Angle:			
1. Site	Sum of angles a, b, and c	Sum of angles a, b, and c	Sum of angles a, b, and c
a. Greatest angle of site reported	As reported	As reported	As reported
b. Vertical angle for clearance of friendly elements	5 meters divided by PC rg expressed up to a whole mil	Appropriate vertical clearance divided by PC range. See note.	Appropriate vertical clearance divided by MAR. See note.
c. Complementary angle of site.	Multiply the CS factor at PC rg (or next greater listed range) by the sum of angles a and b	Multiply the CS factor at PC range (or next greater listed range) by the sum of angles a and b	Multiply the CS factor at MAR (or next greater listed range) by the sum of angles a and b
2. Elevation	At PC range	At PC range	At MAR
3. 2 forks	At PC range	At PC range	At MAR
All angles above are expressed to the nearest 1 mil (always express up)	The sum of angles 1, 2, and 3 equals minimum QE.		
Reported by the XO	MINIMUM QUADRANT ELEVATION, CHARGE (so-and-so), (so many mils)	MINIMUM QUADRANT ELEVATION, FUZE VT, CHARGE (so-and-so), (so many mils)	MINIMUM QUADRANT ELEVATION, FUZE VT, AT ARMING RANGE, CHARGE (so-and-so), (so many mils)
LEGEND: PC—Piece-to-crest CS—Complementary angle of site MAR—Minimum arming range		Note: For appropriate vertical clearance see Table 10-1.	



CHAPTER 11

FIRE COMMANDS

Section I. INTRODUCTION

11-1. General

a. Fire commands give the cannon section all of the information it needs to start, conduct, and cease firing. The initial fire commands include all elements necessary for laying, loading, and firing the pieces. Subsequent fire commands include only those elements that are changed, with the exception of quadrant elevation, which is *always* announced.

b. Normally, fire commands come from the fire direction center or the BOC. The FDC (or BOC) receives fire missions and converts mission information into fire commands. The fire commands are sent to the cannon sections by the best available means of communications. Firing battery supervisors

must insure that the FDC and cannon sections understand and use the fire commands prescribed in this manual. It is imperative that all elements of the gunnery team (FIST, FDC, and firing sections) make every effort to be responsive to the needs of the supported elements. Streamlined calls for fire, FDC procedures, and fire commands have enhanced responsiveness, but in order to achieve the desired results, each individual must understand these procedures.

c. Since numbers make up a large portion of all commands received or given in the firing battery, they must be announced in a clear, precise manner, with snap—like a *command*—and in a voice loud enough to be properly understood. Numbers are pronounced as follows:

NUMBER	PRONOUNCED AS
0	Ze-ro
1	Wun
2	Too
3	Tree
4	Fow-er
5	Fife
6	Six
7	Sev-en
8	Ait
9	Nin-er
44	Fow-er fow-er
80	Ait ze-ro
100.7	Wun ze-ro ze-ro point sev-en
136	Wun tree six
500	Fife hun-dred
1478	Wun Fow-er Sev-en ait
3200	Tree too hun-dred
7000	Sev-en tou-sand
16,000	Wun six tou-sand

11-2. Sequence of Fire Commands

a. Fire commands are announced to a firing battery in the following sequence:

SEQUENCE Element	WHEN ANNOUNCED	
	Initial fire commands	Subsequent fire commands
1. Warning order	Always	Never
2. Pieces to follow/pieces to fire/* method of fire*	Always	When applicable
3. Special ** instructions ● Azimuth ● Do not load ● At my command ● By piece at my command ● High angle ● Use gunner's quadrant ● Primary (left right) sector ● Cancel terrain corrections ● Special corrections	When applicable	When applicable
4. Projectile*	When other than standard	When changed
5. Ammunition lot *	When other than standard	When changed
6. Charge	Always	When changed
7. Fuze/fuze setting*	When other than standard	When changed

SEQUENCE Element	WHEN ANNOUNCED	
	Initial fire commands	Subsequent fire commands
8. Direction	Always	When changed
9. Quadrant elevation	Always	Always
10. Method of fire for effect	When applicable	When changed

*These elements may be designated as standard. Elements so designated will be announced only when something other than standard is to be fired.

**When TGPC are being used, unit SOP will determine what corrections will be applied. Normally, the corrections for the primary sector will be carried on the weapons unless LEFT SECTOR, RIGHT SECTOR, or CANCEL TERRAIN CORRECTIONS is announced by the FDC.

b. Fire commands are given to the cannon sections in a prescribed sequence to—

(1) *Save time.* Issuing fire commands in the proper sequence allows time for the commands to be announced as rapidly as they can be understood and complied with by the personnel of the firing battery and also prevents the omission of an element of data. A prescribed sequence allows several operations to be executed simultaneously. For example, first the sections are alerted, and then the data pertaining to ammunition are given, followed by the deflection and quadrant elevation. This sequence allows the ammunition to be prepared for loading while the piece is being laid for direction and quadrant elevation.

(2) *Eliminate errors.* Each member of the cannon section *must* know the meaning of each element of the fire commands and the sequence in which the elements are announced. Each crewman can then distinguish the numerical portion of one element from that of another element and can be on the alert for the element(s) pertaining to his duties.

c. The chief of section is not permitted to fire his weapon until he has received a complete set of commands. Explanations and examples of all elements of the fire

commands are presented in paragraphs 11-3 through 11-13. Some of the elements listed are used only under special circumstances and are not announced when they do not apply.

Section II. ELEMENTS OF FIRE COMMANDS

11-3. Warning Order

A warning order of

FIRE MISSION

will be announced to the guns as a fire mission is received by the battery. This will alert the crews to stand by their posts and be ready to receive data.

11-4. Pieces to Follow/Pieces to Fire/Method of Fire

a. This element designates the weapons to follow the mission and actually take part in firing.

(1) *Pieces to follow/pieces to fire* alerts the battery as to which sections will fire on the target, either initially or after an adjustment has been made. This command also tells the battery which sections should follow the commands and load if appropriate.

BATTERY ADJUST

indicates that fire will be adjusted onto the target and that the entire battery should follow the commands and fire on the target after the adjustment has been completed. The method of adjustment and rounds to be fired in effect are announced in later elements. Any weapon or combination of weapons may be announced in this element; e.g., *LEFT ADJUST, NUMBER 3 ADJUST*.

BATTERY (so many) ROUNDS

indicates that a fire-for-effect mission (no adjustment) is to be fired. Any combination of weapons may be announced here also.

(2) *Method of fire* tells the battery how many rounds are to be fired during the adjustment and in what manner. This

portion may be standardized; e.g., the base piece fires one round. If a weapon other than the designated standard is to be fired, this information must be announced at this time.
EXAMPLE:

*BATTERY ADJUST,
NUMBER 4,
ONE ROUND.*

This command indicates that the battery is to follow the commands and fire after the adjustment is completed and that number 4 is the adjusting piece for this particular mission. Special methods of fire used in unusual circumstances are discussed in paragraph 11-13.

11-5. Special Instructions

Special instructions are used whenever actions are required that are different from normal. They include:

a. *DO NOT LOAD* is a restrictive command that prohibits the loading and firing of the weapon(s). The section cuts the charge, sets the fuze (if applicable), and lays the weapon on the given deflection and quadrant elevation or applicable loading elevation, but *does not* load the round into the weapon. When these tasks have been completed, the chief of section reports *NUMBER (so-and-so) IS LAID*. When the round(s) is to be fired, the FDC commands *CANCEL DO NOT LOAD* and gives the appropriate quadrant elevation.

b. *AT MY COMMAND* (or *BY PIECE AT MY COMMAND*) is a restrictive command that prohibits the battery (section) from firing until directed to do so by the FDC. The sections lay and load their weapons and,

when ready to fire, the chief of section reports to FDC

NUMBER (so-and-so) IS READY

The FDC will tell the section chief(s) when to fire by commanding

*BATTERY (or NUMBER
(so-and-so), FIRE!*

To return control of firing to the section the FDC announces

*CANCEL AT MY COMMAND
(BY PIECE AT MY
COMMAND)*

and gives the appropriate quadrant elevation.

c. *HIGH ANGLE* is announced to alert the section that the mission is to be fired at an angle of elevation over 800 mils. Light artillery weapons can be elevated before loading to expedite the mission; medium and heavy artillery weapons must be loaded at a loading elevation.

d. *AZIMUTH*, followed by an azimuth in mils, may be sent to the battery to alert them to a large shift in direction. This enables the section to traverse the weapon to this approximate direction of fire.

e. *SPECIAL CORRECTIONS* is announced any time that a separate fuze setting deflection, and/or quadrant is sent to one or more sections.

f. *PRIMARY (LEFT) (RIGHT) SECTOR* is announced when terrain gun position corrections are being used. Ordinarily, the corrections for the *primary* sector are set on the gunner's aids of all the weapons in the battery. These corrections are announced administratively and recorded on the gunner's reference card. To change sectors, FDC commands *LEFT SECTOR* or *RIGHT SECTOR*. Upon termination of the mission, the howitzer sections reapply the corrections that were in effect prior to the mission.

g. *CANCEL TERRAIN CORRECTIONS* indicates that all howitzer sections are to set

their gunner's aid counters to zero. After completion of the mission, the terrain gun position corrections that were in effect prior to the mission will be reapplied unless the FDC indicates otherwise.

11-6. Projectile

The type of *projectile* that will be used to attack a target is announced in the initial commands unless it has been designated as standard. The projectile is not announced in the subsequent command unless a change is desired.

11-7. Ammunition Lot

a. The element ammunition lot indicates the projectile-propellant lot to be fired. The lot number is announced in the initial fire commands unless a specific lot has been designated standard. The lot number is not repeated in subsequent commands unless a change is desired.

b. The lot numbers for semifixed ammunition pertain to an assembled projectile-propellant combination and, for simplicity, are coded lot X, lot Y, etc. The lot numbers for a specific projectile-propellant combination of components of separate loading ammunition are combined. For example, in the command

LOT XY,

X indicates the projectile lot and Y indicates the propellant lot.

c. Large quantity lots are set aside to be fired during registrations and missions when more uniform effect is important. Small quantity lots should be used for adjust fire and other missions when uniform effect is not critical. The sections must segregate ammunition by lot and maintain accurate records of the number of rounds on hand, by lot number.

11-8. Charge

The element *charge* indicates the amount of propellant to be used. As soon as the charge is announced, all powder increments for the

round being fired are inspected and excess increments are removed.

11-9. Fuze/Fuze Setting

The type of *fuze* to be used is announced in the initial fire commands only when it is other than the designated standard. It is announced as a subsequent command only when a change is desired. When VT or time fuzes are fired, this element includes the *fuze setting*; e.g.,

FUZE VT, 59.0

11-10. Direction

Direction is always announced as a *four-digit deflection*; e.g.,

DEFLECTION 3218

The gunner sets the commanded deflection on his panoramic telescope and traverses the tube until he is sighted on the proper aiming point.

11-11. Quadrant Elevation

a. Quadrant elevation is announced in initial and subsequent fire commands. *The command QUADRANT (so much) is permission for the chief of section to load and fire the round unless otherwise restricted by special instructions.*

b. To increase responsiveness, a unit may adopt certain alternate loading procedures as SOP. These include:

(1) *Loading on deflection.* This procedure is especially effective in towed units, where loading may not interfere with receipt of the remaining fire commands.

(2) *Adjusting piece(s) loading subsequent rounds immediately after firing.* This loading method can be used for all projectile/fuze combinations not using a mechanical time fuze. If this procedure is used, it is possible that the adjusting piece may not have the correct projectile/fuze combination loaded when entering FFE. If this occurs, the loaded round will be fired and the remaining FFE rounds will be fired using the correct projectile/fuze combination. At the end of the mission, the chief of section will

report to the FDC that his piece fired ammunition not specified in the fire command. For example, the fire command is 3 ROUNDS VT IN EFFECT. Piece number 4 ★ fired one round with fuze quick and two rounds with fuze VT. The chief of section reports

**NUMBER 4 FIRED 1 QUICK
AND 2 VT IN EFFECT.**

The FDC will make an appropriate correction to the ammunition count. If the FDO decides to terminate automatic reload, he will administratively inform the firing sections prior to announcing quadrant. For example—

**NUMBER 4, CANCEL
AUTOMATIC RELOAD,
QUADRANT 314.**

(3) *Nonadjusting pieces loading the shell to be fired in effect upon receipt of the initial fire commands.* This procedure also applies to all projectile/fuze combinations not using a mechanical time fuze. When the FFE fuze is fuze VT, the FDC calculates the VT fuze setting corresponding to the initial target location and sends it to the nonadjusting pieces. If terrain, weather, and enemy capabilities permit, the FDC can send the VT minimum safe time to the nonadjusting pieces.

c. The decision to use one or more of these alternate loading techniques is made by the commander and is influenced by the state of training of the FDC and cannon sections.

★ **CAUTION: DO NOT LEAVE LOADED ROUNDS IN HOT OR WARM TUBES FOR A PERIOD LONGER THAN THAT SPECIFIED BY THE TECHNICAL MANUAL FOR THE WEAPON.**

11-12. Method of Fire for Effect

This element indicates the number of rounds and type of ammunition to be used in effect, when applicable. It is announced after the quadrant in adjust fire missions so as not to delay the firing of initial data. **EXAMPLE:** If the initial commands include BATTERY

ADJUST, the method of fire for effect might be

ROUNDS IN EFFECT.

11-13. Special Methods of Fire

- ★ *a. ZONE FIRE.* This method of fire is used when the standard sheaf does not adequately cover the target and more depth is required. The number of mils to the zone and the number of quadrants to be fired will be announced by FDC. For example, upon receipt of the command

**ZONE 5 MILS,
5 QUADRANTS**

each chief of section computes the required quadrants and then fires them after the initial quadrant announced in the fire command. If, in this example, the announced quadrant were 310, it would be fired first; the remaining quadrants would be 320, 315, 305, and 300, fired in any order. Note that there will always be an odd number of quadrants.

- ★ *b. SWEEPING FIRE.* This method of fire is similar to zone fire but provides for firing several deflections with one quadrant. For example,

**SWEEP 10 MILS,
3 DEFLECTIONS.**

As in zone fire, each chief of section computes the required deflections and fires them after the initial deflection has been fired. For example, if the announced deflection is 3220, it would be fired first; the remaining deflections would be 3230 and 3210 and would be fired in any order. Again, there will be an odd number of deflections to be fired.

- c. SWEEP AND ZONE.* This method of fire combines zone fire and sweeping fire. The chief of section will first fire the announced deflection and quadrant and then fire all combinations of the computed deflections and quadrants. For example,

**SWEEP 10 MILS, 3 DEFLECTIONS,
ZONE 4 MILS, 3 QUADRANTS.**

If the announced deflection is 3200 and the announced quadrant is 310, the three deflections to be fired would be 3200, 3210, and 3190 and the three quadrants to be fired would be 310, 306, and 314. Each quadrant would be fired with each deflection (total of nine rounds). Deflection 3200 and quadrant 310 would be fired first.

- d. CONTINUOUS FIRE.* When it is desired to fire continuously at a target, the command is

CONTINUOUS FIRE.

At this command, the sections load and fire as rapidly as possible consistent with accuracy and within the prescribed rates of fire for the pieces. The crews continue to fire until commanded to

CHECK FIRING

or

CEASE LOADING.

The command *CEASE LOADING* is preferred, as this allows the section to fire a round that is loaded. When *CHECK FIRING* is announced, a round that is loaded cannot be fired and may present a hazard if the weapon has a hot tube. The command *CHECK FIRING* should be used only in emergencies.

- e. FIRE AT WILL.* If the method of fire is for pieces to fire at will, the command is

**TARGET (so-and-so),
FIRE AT WILL.**

If a method of close defense has been prearranged, the command is simply—

FIRE AT WILL.

At this command, the designated piece or pieces fire under the control of the chief(s) of section as the situation and target necessitate.

Section III. USE OF FIRE COMMANDS

11-14. Standardizing Elements of the Fire Command

a. Certain elements of fire commands may be standardized after consideration of the tactical situation, weapon and personnel capabilities, ammunition status, and enemy counterfire threat. As shown in paragraph 11-2, the following elements of the fire command may be designated as standard: *pieces to fire/method of fire, projectile, ammunition lot, and fuze*. If the FDO decides to vary from fire command standard data, he must administratively cancel the existing standard and issue the replacement standard data. Only one set of standard data can be in effect at any particular time. Once placed in effect, the battery will fire the standard data unless the fire command specifies something different.

b. Example: The FDO considers the tactical situation and the other factors mentioned above and determines that the fire command elements designated as standard should be:

- (1) Pieces to fire/method of fire: Number 3, one round (number 3 will be the adjusting piece and will fire one round in adjustment).
- (2) Projectile: HE.
- (3) Ammunition lot: XY.
- (4) Fuze: Q.

These standards inform the firing battery that during an adjust fire mission, number 3 will adjust and each time will fire one round, shell HE, lot XY, and fuze quick. After firing each round, number 3 can then load another standard round in preparation for the subsequent fire commands. The use of fire command standard data and immediate reloading (if desired) will greatly increase responsiveness.

11-15. Examples of Fire Commands

a. *Standard adjust fire mission.* Elements designated as standard in this example are number 3 firing one round in adjustment, shell HE, lot XY, and fuze quick.

Note. Each section should keep a minimum of six rounds of a designated standard lot of ammunition prepared and ready to fire at all times.

FIRE MISSION, BATTERY ADJUST, CHARGE 6, DEFLECTION 2938, QUADRANT 200, 2 ROUNDS IN EFFECT.

(1) Number 3 fires one round of shell HE lot XY, fuze quick, at the announced deflection and quadrant, and then reloads.

(2) The first subsequent fire commands in this example are:

DEFLECTION 2978, QUADRANT 218.

Number 3 fires the new deflection and quadrant and reloads.

(3) The second subsequent fire commands in this example are:

BATTERY 2 ROUNDS, DEFLECTION 2950, QUADRANT 210.

The entire battery fires two rounds at the announced quadrant and deflection.

END OF MISSION

is commanded as appropriate.

b. *Nonstandard adjust fire mission.* Elements designated as the standard in this example are number 3, one round, shell HE, lot XY, and fuze quick.

FIRE MISSION, BATTERY ADJUST, NUMBER 4, 1 ROUND, CHARGE 4, DEFLECTION 3024, QUADRANT 447, 2 ROUNDS ICM IN EFFECT.

(1) Number 4 is announced as the adjusting weapon and fires one round, shell HE, lot XY, fuze quick at the announced charge, deflection, and quadrant. The remainder of the battery prepares two rounds of ICM and follows the fire mission. The adjustment continues as in the first example.

When fire for effect is entered, the commands are:

**BATTERY 2 ROUNDS, SHELL ICM,
FUZE TIME 24.2, DEFLECTION 3008,
QUADRANT 443.**

(2) The entire battery fires two rounds of shell ICM at the announced time, deflection, and quadrant.

END OF MISSION

is commanded as appropriate.

c. *Standard fire-for-effect mission.* Elements designated as standard in this example are number 3, one round, shell HE, lot XY, and fuze quick.

**FIRE MISSION, BATTERY 2
ROUNDS, CHARGE 4, DEFLECTION
3377, QUADRANT 487.**

Each weapon in the battery fires two rounds of the standard shell, lot, and fuze at the announced deflection and quadrant.

d. *Nonstandard fire-for-effect mission.* In this example, no standard elements are used.

**FIRE MISSION, NUMBER 2, 3, 4, AND
5, 3 ROUNDS, AT MY COMMAND,
SHELL WP, LOT TZ, CHARGE 7,
FUZE QUICK, DEFLECTION 2870,
QUADRANT 320.**

Numbers 2, 3, 4, and 5 each fire three rounds of the announced shell and lot, charge 7, and fuze quick at the announced deflection and quadrant. Since the special instruction AT MY COMMAND was announced, the section chiefs report READY and wait to fire until given permission to fire by FDC.

11-16. Check Firing/Cease Loading

★ a. Normally, the command

CHECK FIRING

is given by the FDC, but it may be given by anyone present. On this command, regardless of its source, firing will cease immediately. The signal for CHECK FIRING is to raise the hand in front of the forehead,

palm to the front, and swing the hand and forearm up and down in front of the face while giving the command CHECK FIRING. Another signal for CHECK FIRING is one long blast on a whistle. Whichever signal is used, it should be continued until all weapons have stopped firing. Firing is resumed at the announcement of CANCEL CHECK FIRING and the quadrant elevation.

b. The command

CEASE LOADING

is similar to CHECK FIRING. Upon receipt of this command, the cannoneers may fire the weapons that are already loaded, but no additional rounds may be chambered. Firing is resumed at the announcement of

CANCEL CEASE LOADING

and the quadrant elevation.

11-17. End of Mission

The command

END OF MISSION

means that the fire mission has been completed. All corrections applied to the fire control equipment for that mission are to be removed. Primary terrain gun position corrections are to remain on the appropriate counters unless commanded otherwise by the fire direction center. If a priority target has been assigned, each section will lay on the appropriate firing data.

Note. The assigned targets may not always be located in the primary sector, so the applicable position corrections (primary, left, right) must be applied to the counters prior to setting off and laying on assigned target data.

11-18. Repetition of Commands

★ a. When radio or wire communications are used between the FDC and the individual sections, the readback of elements of the fire commands is governed by unit SOP. One piece should be designated to read back all

fire commands. If the howitzer loudspeakers are not working, the person designated by the chief of section to operate the radio or telephone must announce each element of the fire command to the section.

- ★ *b.* Chiefs of section repeat the commands FIRE, CHECK FIRING, and CEASE LOADING. Any other fire commands are repeated only when requested or when they obviously have not been heard or understood. The request for repetition is stated as a question; e.g.,

DEFLECTION NUMBER

(so-and-so)?

- ★ *c.* The repetition of commands by the FDC is always preceded by NUMBER (so-and-so), THE COMMAND WAS; e.g.,

**NUMBER 4, THE COMMAND WAS
DEFLECTION 2768.**

11-19. Planned Targets

a. At times the battery will be assigned planned targets, which must be fired quickly. One of these will be designated by the FDC as the priority target, and each weapon will be laid on its assigned priority target when not actively engaged in a mission. Appropriate ammunition will be kept on hand and personnel at the piece will begin firing the weapon as soon as a command is received.

b. One common type of priority target is the final protective fire (FPF). To order the FPF to be fired, the command

FIRE THE FPF

or a prearranged signal is given.

- ★ *c.* In offensive operations, suppressive fires frequently are delivered by the battery. Some of these may be planned fires. If so, each section maintains firing data on these targets as directed by the FDC. These targets are recorded at the section on the Gunner's Reference Card (fig 2-3, p 2-8) in the portion labeled "PRIORITY TARGETS." As a section can be laid on only one priority target at a time, the FDC must designate which of the planned targets is *the* priority target. In this example, the FDC has designated target 43 (see illustration below) as the priority target for the right platoon. These sections would lay on target 43. The command from the FDC to fire would be

(so-and-so) SUPPRESS,

followed by the target number; e.g.,

RIGHT SUPPRESS 43.

If target 54 or 57 is to be fired, the command would be

RIGHT SUPPRESS 54,

which means the platoon would re-lay and fire the data for target 54.

PRIORITY TARGETS									
TGT NO.	SP INST	RDS	SH	LOT	CHG	FZ	TI	DF	QE
43	—	2	HE	XY	6	Q	—	3210	402
54	—	2	HE	XY	6	VT	29.0	3190	418
57	—	4	SMK	TY	6	TI	31.2	3182	432

11-20. Reports

The section chief reports to the FDC all actions that affect the firing of his weapon in support of the battery mission. In the conduct of firing the following *specific* reports are made:

★ *a. SHOT NUMBER (so-and-so)* after each round of a fire mission has been fired unless the method of fire is more than one round in effect, in which case SHOT is announced only after the initial round. If a round or fuze other than the one announced by the FDC is fired, it *must* be reported to the FDC.

★ *b. ROUNDS COMPLETE NUMBER (so-and-so)* when the final round of the round(s) designated in the method of fire is fired.

c. MISFIRE NUMBER (so-and-so) when there has been a misfire. The chief of section reports *NUMBER (so-and-so) IS READY* when the piece is ready to fire.

d. NUMBER (so-and-so) IS OUT (reason) when a piece has been called out of action.

e. Number of rounds expended by type and lot number (when required).

f. Chiefs of section must tell the FDC if any round has been fired with improper data. The chief of section will report the actual data fired in error, e.g.,

**NUMBER 2 FIRED
DEFLECTION (so much).**

The executive officer has the error(s) corrected and reports to the battalion FDC, e.g.,

**NUMBER 2 FIRED
20 MILS RIGHT.**

11-21. Correcting Fire Commands

a. If an incorrect command has been given but the command QUADRANT has not been announced, the FDC commands

CORRECTION

and then gives the correct command and all subsequent elements.

b. If QUADRANT has been announced, the FDC commands

CHECK FIRING.

Then

CANCEL CHECK FIRING

is announced, followed by the proper element and all subsequent elements.

11-22. Miscellaneous Commands

a. Special corrections. In addition to the special corrections indicated in paragraph 11-5, other special corrections may be announced administratively; e.g., position corrections or instructions to open or close the sheaf for a particular mission. The commands are:

**SPECIAL CORRECTION,
NUMBER (so-and-so),
LEFT 7.**

This command may be given administratively, apart from fire commands, or may be announced in the SPECIAL INSTRUCTIONS element of fire commands.

**SPECIAL CORRECTIONS, ON
BASE PIECE
(or NUMBER so and so),
OPEN (CLOSE) (so many).**

In this example, each piece other than the base piece applies a correction to the announced deflection by placing the correction on the gunner's aid. Each gunner determines his correction by multiplying the correction announced in the command by the number of pieces his piece is removed from the one on which the sheaf is to opened or closed. For example, the command

**ON NUMBER 3,
CLOSE 4**

is given. Number 3 fires the announced deflection. Number 1 applies left 8; number 2, left 4; number 4, right 4; number 5, right 8; and number 6, right 12. These corrections are applied to any position corrections already on the gunner's aid, and remain in effect until the command END OF MISSION is given.

b. *Referring to an aiming point.* To have a weapon or the battery refer to a particular aiming point, the XO, CFB, or GSG commands

*AIMING POINT (whatever),
REFER.*

If he desires to know the referred deflection, he also commands

REPORT REFERRED DEFLECTION.

If it is desired that the indicated weapon(s) make this aiming point its (their) primary aiming point, then after referring the piece(s) to the aiming point as in the example above,

the command

*DEFLECTION (common deflection)
REFER*

is given. For example, the commands

*NUMBER 4, AIMING POINT
CHURCH STEEPLE,
REFER. DEFLECTION 3200
REFER.*

are given. The gunner then refers to the church steeple, sets the announced deflection on the reset counter (or slipping azimuth scale), and uses this new aiming point as his primary aiming point.



CHAPTER 12

SPECIAL SITUATIONS

Section I. ASSAULT FIRE

12-1. General

a. Assault fire is a special technique of indirect fire. Fire is conducted at a relatively short range to obtain pinpoint accuracy against a stationary target (e.g., bunkers or caves). The gun-target range is sufficiently short to make possible successive hits on the same portions of the target. Only one piece is used on a mission, and the fire direction center (FDC) or BOC is located at the cannon position. Thorough planning, reconnaissance, and coordination must be completed before the position is occupied. Since field artillery is at a premium, this technique should be considered *only* after maneuver force weapons, such as tanks, have failed, or because terrain prohibits their use.

★ b. Any field artillery cannon can be used for assault fire; however, any caliber smaller than 155-mm is considered impractical. The most efficient weapons, in order of preference, are the 8-inch howitzer, the 155-mm howitzer and the 175-mm gun. Self-propelled weapons are best suited for this task because of their maneuverability and ease and speed of emplacement and displacement.

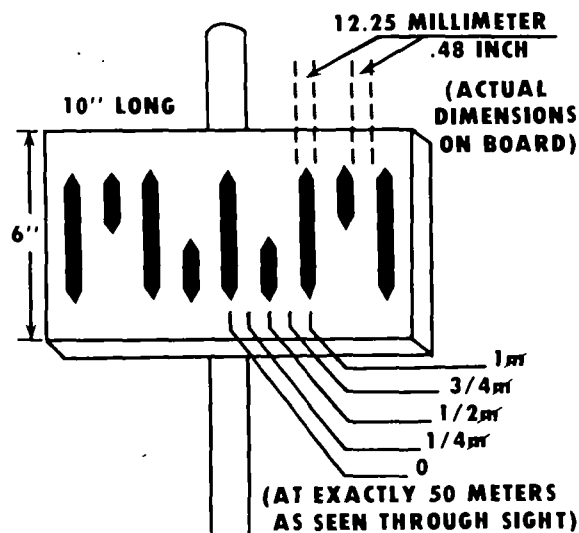


Figure 12-1. Deflection board.

M100-series sights. For weapons with M12-series sights, a deflection board (which must be locally fabricated) attached to an aiming post (fig 12-1) enables the gunner to make

12-2. Assault Fire Procedures

a. Normal fire direction procedures and fire commands are used; however, in order that the small deflection changes that are necessary in assault fire can be made, a special technique of laying is employed at the piece.

b. Deflection changes are made to the nearest mil until a 1-mil deflection bracket has been obtained; further changes are made to the nearest one-fourth mil. *One-fourth mil can be set on weapons equipped with the*

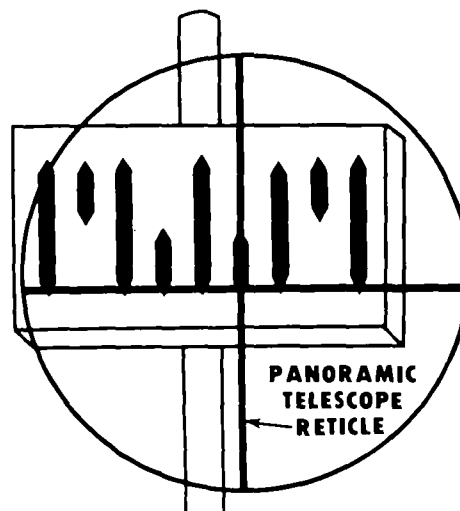


Figure 12-2. Gunner's sight picture.

deflection changes to one-fourth mil. The black and white bands (lines) are one-fourth mil in width when viewed through the sight of the piece at a distance of exactly 50 meters.

c. One board per howitzer is required. The gunner lays on the desired portion of the board by centering the vertical crosshair of the sight on a black (white) band on the board. To move one-fourth mil, he moves the line of sight by traversing the piece in the

proper direction so that the adjacent white (black) band is covered; to move one-half mil he moves the vertical crosshair until the second band is covered, etc. Figure 12-1 shows the sight picture when deflection is moved to the right by one-half mil. For changes in elevation to the nearest 0.1 mil, the gunner's quadrant is used.

d. For adjustment and fire direction procedures, see FM 6-40.

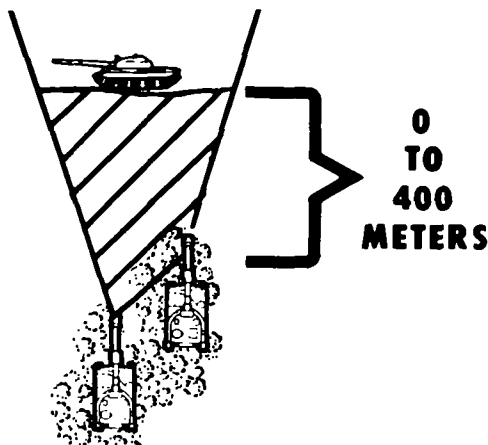
Section II. DIRECT FIRE

12-3. General

a. Direct fire is a special technique that demands a high standard of training. The section must operate as an independent unit. Enemy targets taken under fire by direct fire procedures are usually those capable of returning direct fire; therefore, speed and accuracy are of the utmost importance. The commander *must* bear in mind that direct fire is used as a *last resort only*, after the location of the battery has been detected by an enemy force *and* that force has launched an attack.

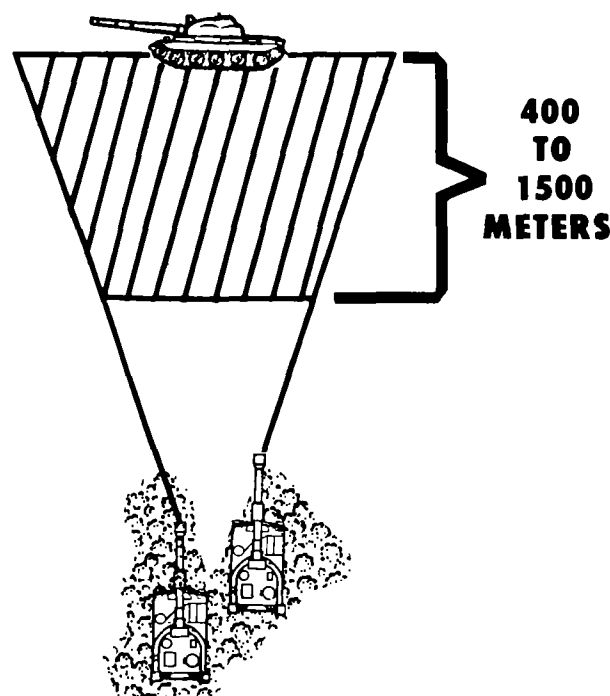
b. The trajectory of the weapon involved, types of targets, and the types of ammunition and fuzes to be employed against various targets must be considered by the XO. The maximum charge should always be used for direct fire. Here are some considerations for trajectory, types of targets, and ammunition.

(1) Trajectory. Trajectory characteristics change with the type of ammunition and the charge fired. The following information is based on use of charge 7.



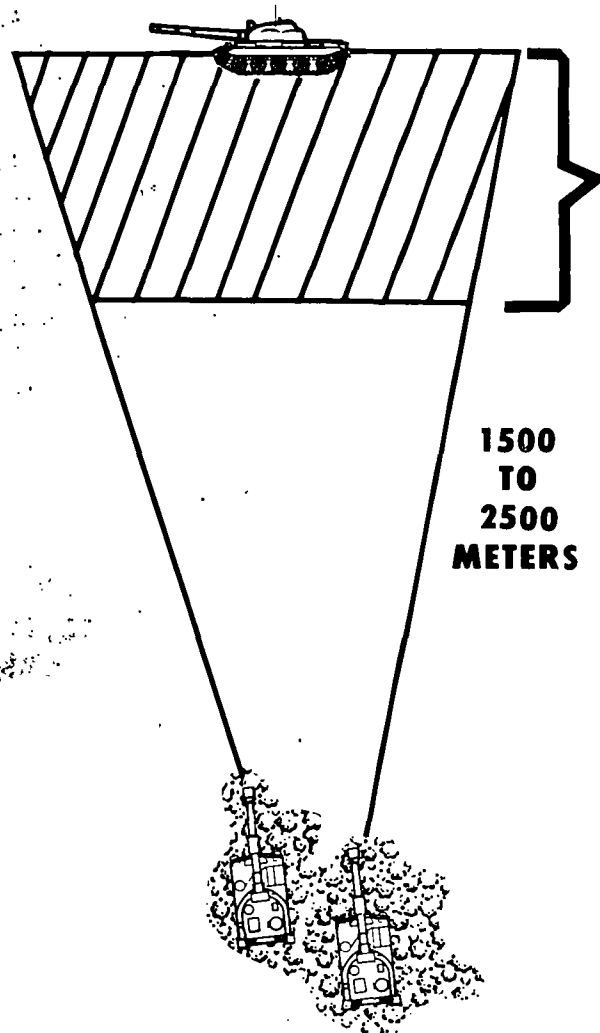
(a) 0-400 meters. Within this range the trajectory will be flat enough to prevent an 8-foot tank from passing safely under it. The optimum range at which to engage a target with direct fire is 400 meters. Terrain allowing, targets should be engaged at as close to 400 meters as possible.

(b) 400-1,500 meters. In this zone the trajectory is flat enough to allow direct estimation of range without actual bracketing of the target. Assuming little dispersion, if you obtain a hit at the bottom of an 8-foot tank when firing at 1500 meters, a 100-meter increase in range will give you a round that will just brush the top of the tank.



If adjusting within this zone, range changes of more than 100 meters should *not* be made. Usually, range changes in 50-meter increments will give the best results. The upper limit (1500 meters) of this zone is considered the maximum range at which a target should be engaged except in unusual situations. Within this zone, a well-trained crew should require no more than two shots to obtain a hit.

(c) 1500-2500 meters. Hits are only reasonably possible in this zone, and the bracket method of adjusting will probably be required to obtain a hit. Do not engage a target at these ranges unless absolutely necessary.



(d) Over 2500 meters. In this zone direct laying is not advised, as a *hit on a*

moving target, even with accurate bracketing and range estimation is very unlikely.

(2) Types of targets. The most likely direct fire targets are vehicles, tanks, and/or dismounted personnel that are threatening the battery. Enemy personnel, alone or with tanks, will not usually present themselves as clearly defined targets. In this case, fire should be delivered in the area containing the attackers rather than on the individuals. Tanks usually attack in groups and may be accompanied by infantry. Priority within a given sector of direct fire should be given to—

(a) Tanks at short ranges threatening to overrun the position.

(b) Hull-down stationary tanks covering the advance of other tanks.

(c) The commander's tank, if identified.

(d) Tank(s) nearest to cover.

(3) Ammunition and fuzes.

(a) Ammunition. Against armor and vehicles.

Antitank ammunition, high-explosive, plastic-tracer (HEP-T), available for 105-mm only, is best.

The high-explosive shell is effective against armor and vehicles, but you must attempt to hit a vulnerable portion of a tank (e.g., side view, the track or road wheels; front view, between the carriage and the turret).

★ Smoke or white phosphorus projectiles can be used very effectively to obstruct the vision of tank gunners.

The white phosphorus shell is excellent for setting immobilized tanks and vehicles on fire.

(b) Ammunition against personnel.

The beehive antipersonnel round (105-mm only) is very effective.

The high explosive shell with VT or mechanical time fuze is lethal against unprotected troops, can separate infantry from tanks, and effectively causes the tank crews to "button-up."

(c) Fuzes.

When the HE round is fired against tanks or vehicles, the impact fuze should be used in the superquick mode.

Against personnel, the impact fuze in the delay mode may cause an effective ricochet effect. When the delay mode is used, the point of impact must be adjusted 10 to 30 meters in front of the target. If the ground is such that less than half the shells can be expected to ricochet, the superquick mode should be used.

As mentioned above, proximity and mechanical time fuzes can be used with the HE shell against personnel; however, the mechanical time fuze will generally give erratic results.

12-4. Sighting

There are three primary methods of sighting used in direct fire:

a. Two-man, two-sight. This method is *best* for all weapons *except* the 155-mm howitzer M114A1. The gunner establishes lead with the panoramic telescope and the assistant gunner establishes elevation with the direct fire telescope. This is the fastest and most accurate method of sighting and permits the assistant gunner to check the direction of lead. The reticle in the direct fire telescope *must* be level. A canted reticle in the direct fire telescope will prevent satisfactory direct fire on moving targets because an unacceptable range error is introduced when lead is changed.

b. Two-man, one-sight. This method is *best* for the M114A1. The gunner establishes lead with the panoramic telescope and the assistant gunner sets elevation on the elevation quadrant at the command of the chief of section. This method is *not* effective when the target is moving on other than flat terrain.

c. One-man, one-sight. This method is *least desirable* and should *not* be used unless absolutely necessary. The gunner lays for lead and elevation with the reticle of the panoramic telescope. This method should *not* be used if the target is moving on a steep slope.

12-5. Laying

There are two primary methods of laying:

a. Reticle laying with deflection zero. This method is *best for the M12-series sights*. The gunner maintains lead by placing the vertical hairline the proper number of mils ahead of the point of aim on the target (fig 12-3).

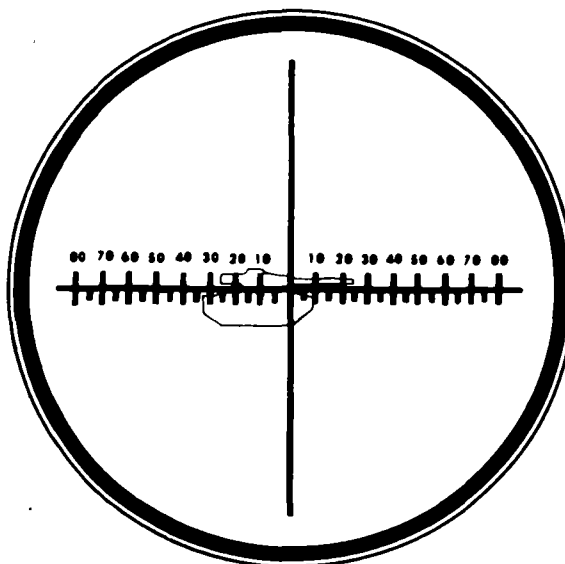


Figure 12-3. Gunner's sight picture, reticle laying, lead right 10 mils.

b. Central laying. This method is *best for M100-series sights*. The gunner sets the lead in mils on the azimuth micrometer scale of the panoramic telescope and maintains the vertical hairline of the reticle on the center of the target (fig 12-4). A modification on the knob of the M100-series panoramic telescope, called click sights, permits the gunner to set off lead in 5-mil increments, by sound or feel, without removing his eye from the sight.

12-6. Commands

a. Commands for direct fire are normally given by the howitzer section chief. The commands include—

- (1) A warning order—TARGET (so-and-so).
- (2) General direction to the target—LEFT FRONT.
- (3) Lead in mils (how to determine lead is

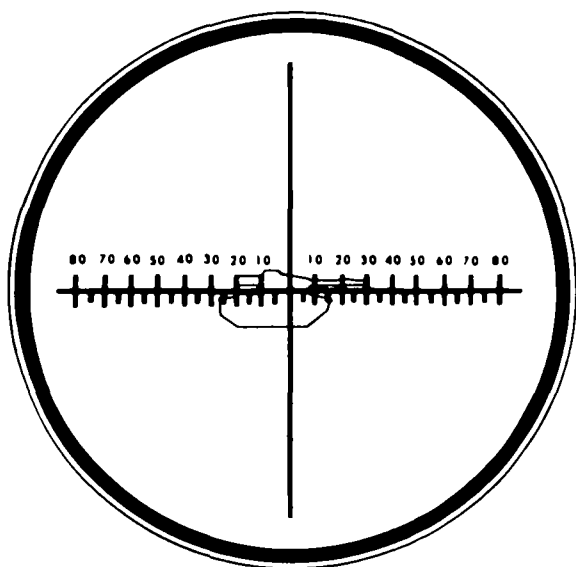


Figure 12-4. Gunner's sight picture, central laying.

explained in the weapon manual)—LEAD, LEFT 5.

(4) Range to the target (or quadrant for the M114A1)—RANGE 500.

(5) Method of fire—FIRE AT WILL.

b. The shell, fuze, and charge to be fired should be standardized in order to save time. If a shell/fuze combination other than the standard is desired, the command SHELL (so-and-so) FUZE (so-and-so), with time (if applicable) is given after the direction to target.

Section III. SPLIT BATTERY OPERATIONS

12-7. General

Tactical considerations may dictate that a cannon battery be split into separate firing elements. Survivability will probably preclude radio transmission of fire commands and require that each split element have its own fire direction capability. A battery FDC that has the normal complement of personnel and equipment can be split for operations of short duration. The battery operations center (BOC) will normally accompany the split element.

12-8. Splits of Limited Duration

a. *Personnel.* Split operations usually require firing of all types of missions, so cross-training is essential. Suggested personnel for a reduced-crew FDC are—

(1) *Fire Direction Officer.* The battery commander, executive officer, or assistant executive officer should be prepared to perform this function.

(2) *Computer.* Each reduced-crew FDC should have an individual capable of determining chart data and computing firing data. In a FADAC-equipped FDC the

FADAC operator (HCO) should be cross-trained to perform manual firing computations.

(3) *Radiotelephone operator.* In addition to normal duties, this individual should know how to determine chart data and compute site.

b. *Equipment.*

(1) Logistical and mobility considerations usually dictate that FADAC remain with the main element and that manual computations be performed in the BOC.

(2) Persons acting as computers should be trained in the use of the GFT fan. This modified RDP allows computation of both chart and firing data by one person and facilitates a one-man manual backup to the FADAC.

(3) Additional radios may be necessary for the split element to perform its mission.

12-9. Sustained Split Battery Operations

Experience has shown that an FDC that is split for long periods of time and operated on

a 24-hour basis must be augmented in both personnel and equipment. Further augmentation may be required on the battlefield where frequent moves and position hardening are commonplace. Failure to augment under such circumstances may result in frequent errors

and reduced responsiveness. Cross-training of other battery personnel in fire direction procedures is necessary. Specific makeup of the FDC depends on proficiency of personnel and length and intensity of the split operations.

Section IV. EMERGENCY BORESIGHTING

12-10. General

a. Boresighting is the only means a gunner has of insuring that the optical axes of his sights are parallel to the tube of the weapon. The weapon should be boresighted—

- (1) Any time the sight has been subjected to any shock other than firing.
- (2) Prior to firing in a new firing position.
- (3) Any time the howitzer fires inaccurately for no apparent reason.

b. The primary methods of boresighting in a combat situation, in order of preference, are—

- (1) Boresight alinement device.
- (2) Distant aiming point (DAP).
- (3) Testing target.

In situations where time is not critical and the tactical situation permits, use of the testing target may be preferred over the DAP method because of its accuracy.

c. All these methods are discussed in detail in the applicable weapon manuals. This section describes several boresighting techniques that may be employed if, for some reason, one of the primary methods is not possible.

12-11. Collimator Method

The collimator may be used to boresight weapons when methods outlined in paragraph 12-10 cannot be used.

a. Prepare the weapon for boresighting in the same manner as for the DAP method.

b. Place the M1 infinity collimator about 20 feet in front of the tube.

c. Sight through the tube and aline the 0 of the collimator with the vertical muzzle boresight string.

d. Sight on the collimator with the panoramic telescope matching the numbers on the sight with the numbers on the collimator. The reading should be 3200. If it is not, adjust the reading.

12-12. Standard Angle Method

a. For the M101A1, M114A1, M110, M110A1 or M107, the standard angle must be established during the conduct of a fire control alinement test. The procedures are outlined in the applicable weapon manuals. To boresight by the standard angle method (fig 12-5)—

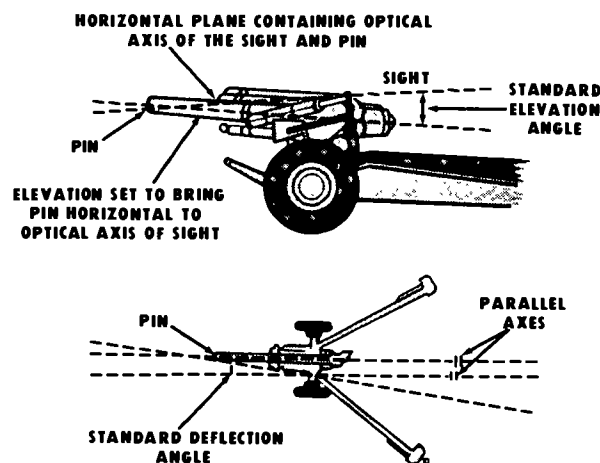


Figure 12-5. Standard angles.

(1) Establish the recoiling parts in the same relationship to the nonrecoiling parts as they were when the standard angle was established.

(2) Place a pin in the left witness mark on the muzzle.

(3) Install the parallax shield.

(4) Set the standard deflection angle on the telescope.

(5) Using a tested gunner's quadrant set the standard elevation angle.

(6) Match all scribed lines.

(7) If the weapon is out of boresight, do not disturb the bubbles; adjust the vertical hairline onto the junction of the pin and the muzzle.

b. As soon as possible, the boresight should be verified by a more accurate means.

12-13. Aiming Circle Method

a. Set up the aiming circle approximately 30-50 meters in front of the weapon. See figure 12-6.

b. Insert the boresight disks and strings in the cannon.

c. With the UPPER motion of the aiming circle, set off 0000 (for M12-series sights) or 3200 (M100-series sights).

d. Aline the cannon bore on the aiming circle, and level the cross-level bubble of the pantel.

e. With the LOWER motion of the aiming circle, aline the vertical hairline on the center of the cannon bore.

f. With the UPPER motion of the aiming circle, aline the vertical hairline on the pantel of the weapon, and read the instrument

reading (angle from center bore to pantel) to the weapon.

g. The gunner then sets the announced reading on the pantel and adjusts the pantel by using the tangent screws, or the boresight adjustment shaft, until his sight picture is centered on the lens of the aiming circle.

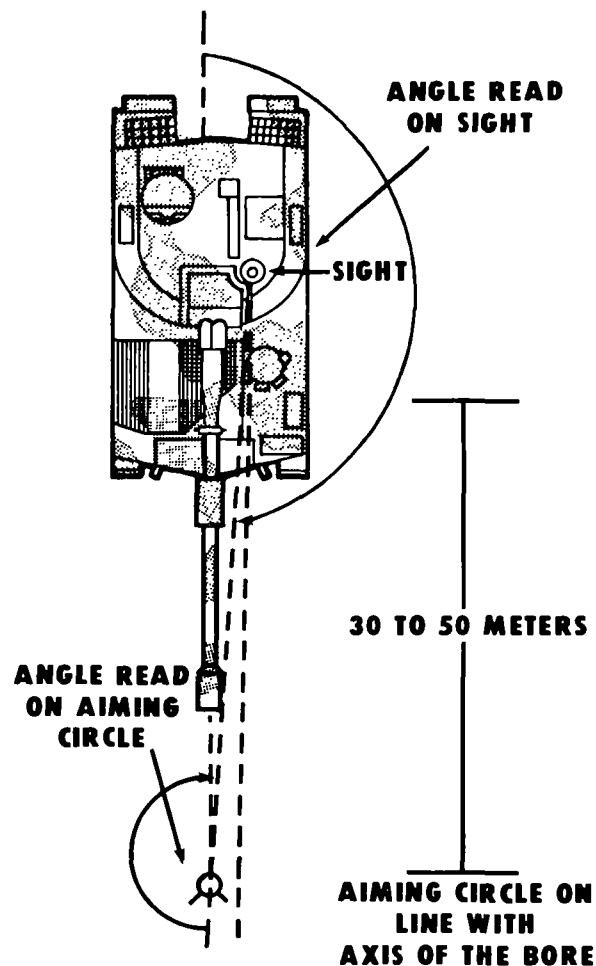


Figure 12-6. Alining the sight parallel to the axis of the bore by use of an aiming circle.



CHAPTER 13

COMMUNICATIONS

13-1. Introduction

a. In our ability to communicate on the battlefield, we face two obstacles—frequent moves and the enemy's sophisticated electronic warfare capability. Communications systems must be oriented toward overcoming these obstacles.

b. The cannon battery has available to it two major communications systems—the *radio system* and the *wire system*. Initially, radio is the primary system; however, as soon as the wire system is installed, it becomes primary. Each has different capabilities, vulnerabilities, and limitations and each must be employed to complement the other.

c. Frequent moves will almost certainly increase the battery's reliance on radio communications. Unfortunately, the enemy is equipped and trained to employ electronic warfare effectively. If the enemy jams a battery's radio communications, he has probably reduced the effectiveness of that battery.

d. Another aspect of the enemy's electronic warfare capability is his use of radio direction-finding equipment, which indicates the position of transmitting radios. A longwinded radio operator may well find enemy artillery pouring in on his position within minutes. The most effective way to combat this threat is the use of STRICT COMMUNICATIONS DISCIPLINE. Units must be able to march under absolute radio listening silence. Fire nets must remain unused until needed for support of the maneuver element. The commander can counteract the enemy's electronic warfare capability by enforcing wise, disciplined utilization of all the communications assets available to him. This cannot be accomplished without a thorough training program—not just for the communications section, but for all the people in the battery who use communications equipment. Some tips for the conduct of this training are in the latter part of this chapter.

13-2. The Battery Radio System

★ a. The cannon battery operates radios in the battalion command/fire direction nets (CF1 and CF2) as directed by battalion headquarters. When the small unit transceiver (SUT) AN/PRC-68 is issued, the battery also will operate a battery command fire (CF) net (para 13-9). Additional requirements may be as follows:

(1) The battery in a direct support battalion may operate in one of three fire direction nets (F1, F2, F3). Normally, these nets are assigned one per cannon battery. Principles of operating the FD nets are—

(a) Expose FD nets only on *demand* of the FIST or as directed by the battalion FDC.

(b) *Never* use the FD net for administrative traffic.

(2) When operating in a dedicated role, the battery will monitor the command net of the maneuver company/team receiving dedicated support.

(3) Normally, general support, general support-reinforcing, and reinforcing units operate in only one FD net, but it is conceivable that a reinforcing or GSR battalion could be given the task of dedicating one of its batteries to a maneuver unit. That battery's communications requirements would be the same as those of the direct support unit in the dedicated role.

b. The wire communications requirements for the FDC and BOC are discussed in paragraph 13-5. The optimum battery radio system is shown in figure 13-1. For maximum

flexibility, all cannon units should try to distribute their radios in this manner. The BOC should have one VRC-47 installed, and the battery commander's VRC-47 should be remoted into it when his vehicle is in the area.

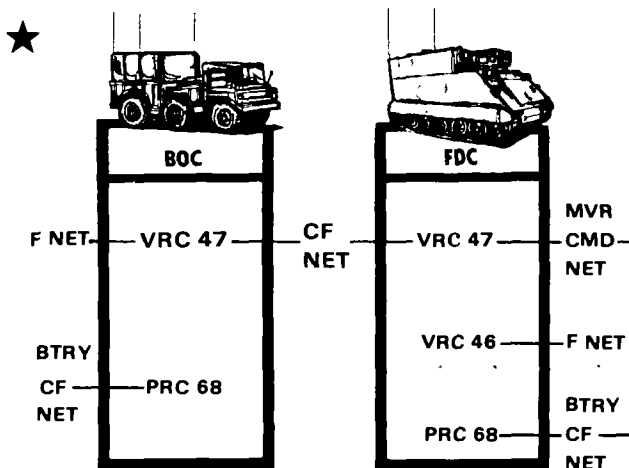


Figure 13-1. Cannon battery radio communications.

13-3. Radio Communications Discipline

Communications discipline must be an item of command concern. It should be integrated into all training and emphasized over and over. The following are some ways to enhance communications discipline:

- a. Thorough SOPs and use of both the operating and brevity codes contained in the CEOIs can substantially reduce the number and length of required radio transmissions.
- b. Runners should be utilized whenever feasible.
- c. Lengthy radio transmissions must be forbidden.
- d. Operators must resist the temptation to make frequent radio checks.
- e. Low power settings should be used whenever possible.
- f. Reports and statistical updates should be closely examined. Only those absolutely necessary should be sent by radio.

g. The battery should habitually displace under radio listening silence. This requires command emphasis and training. It will become even more difficult when the cannon sections are provided radios.

Table 13-1. Radio Operator Performance Objectives

1. Install a radio and begin operation.
2. Troubleshoot communications equipment when failures occur.
3. Erect the RC-292 antenna, assemble it properly for a particular frequency, and disassemble it (BOC and FDC personnel only).
4. Perform operator-level maintenance on a radio.
5. Remote a radio set (FDC and BOC personnel and BC's driver).
6. Know the structure of the unit's radio net.
7. Use the CEOI, unit SOP, and authorized codes.
8. Use correct radio transmission procedures.
9. Identify enemy jamming and imitative communications actions and take proper countermeasures.
10. Set up, install, and operate electronic speech security equipment, to include use of the code changer key.
11. Site radio antennas for effective communications and safety.

13-4. Tips for Training Radio Operators

The battery communications system is only as good as its operators. The following

guidelines are offered as an approach to developing an effective training program for radio operators. A list of specific performance objectives for radio operators is in table 13-1.

a. Identify the principal radio operators and backup operators. This group will include *anyone*, regardless of MOS or grade, who will normally operate a radio set.

b. Radio operators should be trained weekly, as a minimum. This drill should exercise as many of the skills indicated in table 13-1 as possible. Much realism can be integrated into the training if actual battery radio transmissions on field exercises, CPXs, etc. are recorded and then used in developing a drill format.

c. The drill sessions should be recorded, if possible. This allows the operator to hear himself and identify his own weaknesses.

d. Putting up the RC-292 antenna and trimming it properly takes a lot of practice. The FDC and BOC personnel should be drilled regularly in this task and should strive for a time of 5 minutes or less.

e. Training should also include taking the antenna down to change frequencies once it has been erected.

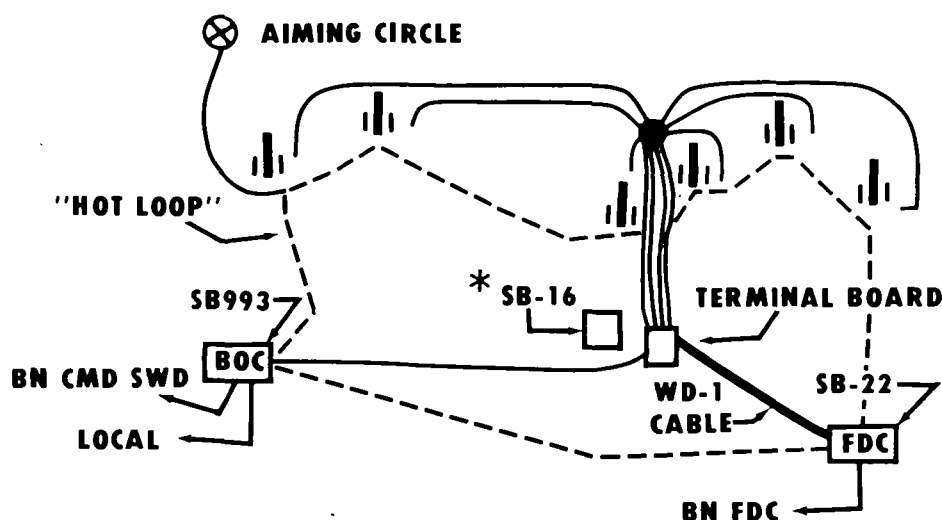
f. Commanders should insure that the antenna is habitually erected and that personnel are as proficient at this task during darkness as they are during daylight.

★ g. Training should include the installation and operation of the AN/GRA-39 to remote radios.

13-5. The Battery Wire System

a. Ordinarily, all the wire teams will be consolidated under the control of the battalion communications platoon. This system allows a vehicle for each wire team and speeds up the establishment of wire communications between the battery and the battalion headquarters. It is the responsibility of the battalion wire team, then, to furnish both command and fire direction circuits to each battery.

b. Cannon battery personnel within those sections that use wire communications (FDC, BOC, howitzers, etc.) must be trained to establish, protect, and repair the intrabattery wire communications system. A suggested system is shown in figure 13-2.



* NOTE - SB-16 IS USED TO LAY THE BATTERY INITIALLY

Figure 13-2. Intrabattery communications.

c. In this system, the SB-16 (MX-155) is set up initially (preferably by the advance party) to lay the battery. Each cannon lays a line to it. Wire lines from the DR-8s at the sections are routed around a stake in front of the line of metal to insure that they are not torn up by local traffic in the area. The XO plugs a line from the aiming circle into the DR-8 of the nearest cannon. Using wire, he then lays the battery. This allows the drivers to observe the proper engine shutdown procedures without disturbing the laying process.

d. The terminal board (fig 13-3) is set up next to the SB-16 by the XO's driver or someone in the FDC. The wire lines (which must be tagged or colorcoded) that are plugged into the SB-16 for laying the battery are easily transferred to the terminal board.

e. The FDC has a preassembled cable of seven pairs of WD-1 attached to the TM-184 portion of the terminal board. Ordinarily, these wires can remain hooked up during movement. The other end of the cable is attached to the FDC SB-22 switchboard.

f. The BOC also lays one line to the terminal board. All lines should be buried or overheaded as soon as possible for protection. Once all wire lines have been transferred to the terminal board, the SB-16 is taken up to be used again by the advance party.

g. The terminal board, which must be fabricated locally by using units, is essential for efficient simultaneous handling of

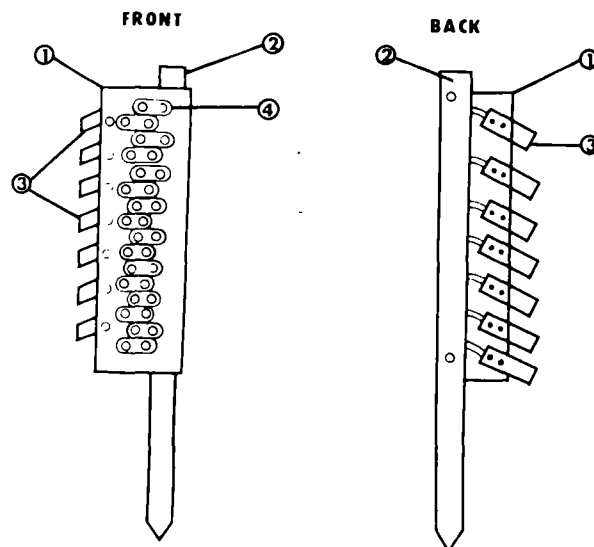
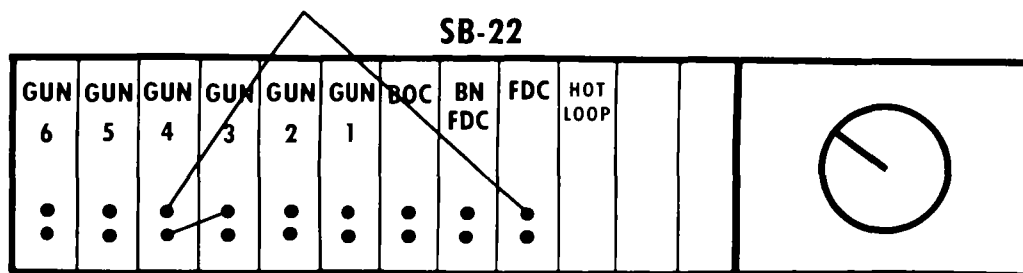


Figure 13-3. Terminal board.

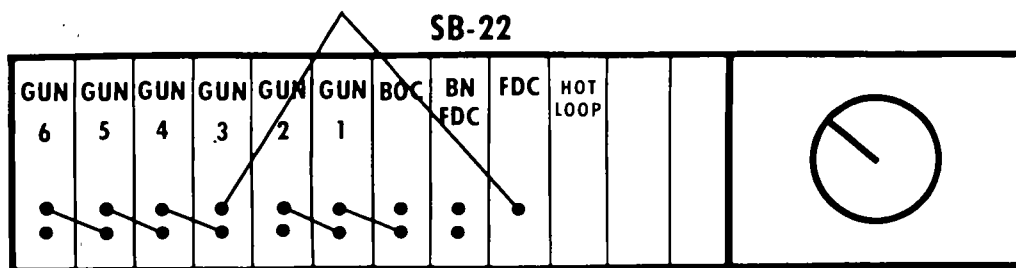
multiple fire missions. It consists of a TM-184 circuit board (1, fig 13-3) mounted on a steel stake (2, fig 13-3). The steel stake mount should be sharpened to a point at the bottom so that it can be driven into the ground. Seven U-17 jacks (3, fig 13-3) are screwed into the back of the TM-184 and wired to their respective posts (4, fig 13-3). This system allows maximum selectivity for the FD computer.

h. To give the BOC a switching capability, the SB-993 is used. Administrative lines, such as those to battalion headquarters and outposts, should be routed into the BOC. The following are examples of the flexibility this system allows.

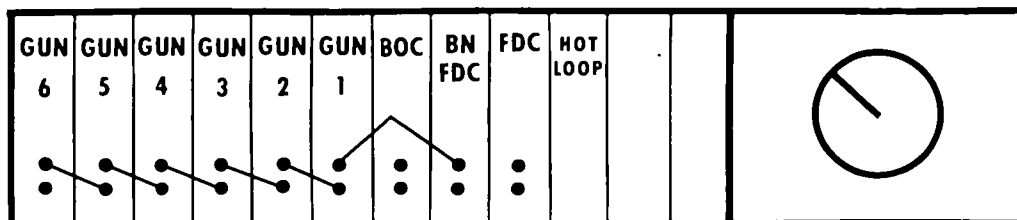
EXAMPLE 1—FDC firing center platoon only.



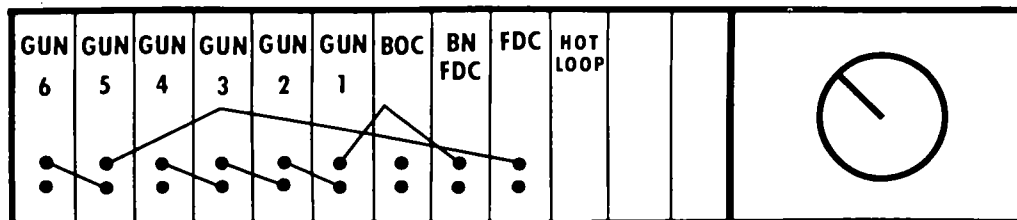
EXAMPLE 2—BOC firing right platoon, FDC firing center and left platoons.



EXAMPLE 3—In this example, the battalion FDC is controlling the fires of the battery. A suppressive fire mission is received at the battery from one of its FIST observers;



so, to fire the left platoon, battery FDC seizes control like this—



i. As soon as time permits, a "hot loop" should be laid for a backup as shown in figure 13-2, but it is not hooked up to the cannons until it is needed. The FDC and BOC hook up the hot loop to their switchboards. If, during a mission, one cannon loses its communications, its telephone should be immediately disconnected from the line to the terminal board and hooked up to the hot loop. The FDC is called and uses the hot loop circuit to communicate with that cannon until the line to the terminal board is repaired. If the seven-pair cable is broken, everyone utilizes the hot loop until repairs are made. (If you use WD-1 to make that cable, you will find it harder to damage and easier to repair than commercial types of cable.)

13-6. Priorities

Wire lines should be laid according to the

following priorities:

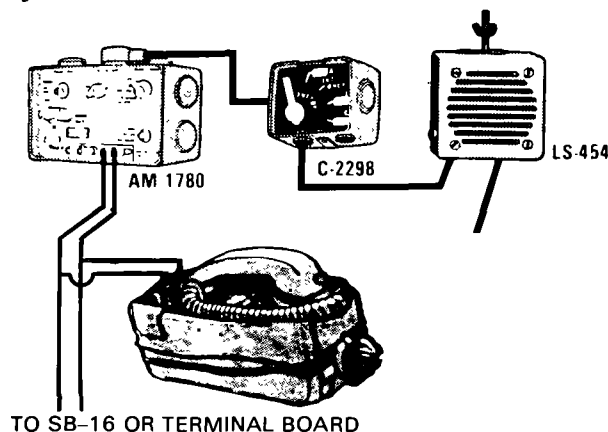
- All cannons plug into the SB-16.
- Wire lines are transferred to the terminal board. The BOC and FDC hook up into the terminal board.
- Outpost lines are laid by outpost personnel.
- Hot loop backup is laid.
- Administrative lines are installed.

13-7. Enhancing Wire Communications

a. One of the serious drawbacks of using the field telephone is that only the telephone operator hears the conversation. He must then relay the fire commands, and there is no check on what he says. One way of alleviating this problem and freeing one man

from monitoring a telephone is to use amplifiers and speakers at the howitzer and in FDC.

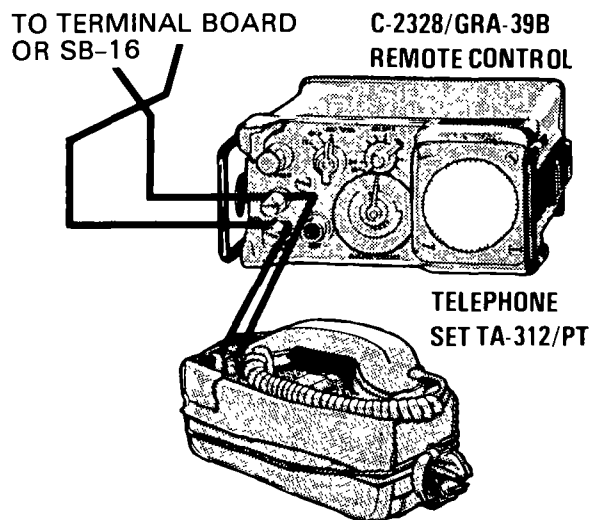
- ★ *b.* To install speaker LS-454 in self-propelled units, the wire system may be run into the AN/VIC-1 intercommunications system as shown here.



A speaker LS-454 is hooked into control box C-2298 in the howitzer. The wire from the terminal board or SB-16 is connected to the AM-1780 at the two wire terminals on the right. The TA-312 is also connected to this wire to provide two-way communication. The switch settings on the AM-1780 and C-2298 are critical for this type of operation. On the AM-1780, if vehicle battery power is applied at J-508 (normal power connection when no radio equipment is provided), the switch settings are: POWER CKT BKR, ON; MAIN PWR, INT ONLY; INT ACCENT, OFF; RADIO TRANS, any position; INSTALLATION SWITCH, INT ONLY. If vehicle battery power is applied at J-501 (normal power connection when radio equipment is provided), the switch settings are the same except: MAIN PWR, NORM; INT ACCENT, ON; INSTALLATION SWITCH, OTHER. An obvious advantage of using this system is that all key members of the crew (chief of section, gunner, assistant gunner) hear the fire commands. Command emphasis must be placed on keeping the intercommunications systems operational. Both the artillery mechanic and the battery communications chief are qualified to troubleshoot the system. Routine maintenance is covered in the weapon technical manual. The AN/VIC-1 does not permit simultaneous transmit and

receive operations, so strict communications discipline must be maintained.

- ★ *c.* In towed units and self-propelled units that may have inoperative intercommunications systems, the remote unit C-2328/GRA-39 (shown below) should be placed at the howitzer and connected to the line from the terminal board (or SB-16) to the TA-312.



13-8. Training in Wire Operations

The personnel who utilize the intrabattery wire communications system are responsible for establishing it. This means that the cannon section, FDC, and BOC personnel must *all* know how to lay and splice wire, dig it in or overhead it, and operate their respective pieces of equipment. Table 13-2 is a list of tasks and appropriate personnel to perform those tasks. This training should be integrated into the field training of the unit.

★ 13-9. The Small Unit Transceiver

a. In the future, each cannon section, FDC, and BOC will have a small unit transceiver, the AN/PRC-68. These radios are *not* intended to be used as the primary means of communications between the howitzer and the FDC. They are to be used to complement wire communications.

b. Because the positions occupied by the battery are spread out, installation of a hot loop backup to the wire system is quite time consuming, and the hot loop would have the same vulnerabilities to disruption as the

Table 13-2. Wire Communications Tasks

TASKS	PERSONNEL				
	FDC	BOC	HOWITZER SECTION	OUTPOST PERS	COMMO SEC
Set up, operate, and maintain the telephone TA-312	X	X	X	X	X
Install and operate the switchboard SB-22	X				X
Install and operate the switchboard SB-993	X	X			X
Perform operator-level maintenance on assigned equipment.	X	X	X	X	X
Check field wire WD-1 for both open and short circuits.	X	X	X	X	X
Repair broken wire lines.	X	X	X	X	X
Hook up the hot loop.	X	X	X		X
Hook up wire to an SB-16 and the terminal board.	X	X	X		X
In SP units, operate the intercommunications system AN/VIC-1. Interconnect CVC helmets, telephones, and the loudspeakers LS-454 to the system.	X		X		X
In towed units, provide a loudspeaker capability for a wire circuit using a remote unit C-2328/GRA-39.	X	X	X	X	X
Overhead and/or bury wire lines correctly.	X	X	X	X	X

primary wire circuit. The radio provides a means of continuing the mission while the hot loop is being installed or during periods when wire is disrupted by enemy action.

c. The radio can be the primary means of communication while the battery is being laid and until the wire circuits are installed. It can also be used to transmit fire commands, if necessary, while the wire system is being march ordered for battery displacements. The radios can be used for communications with supplementary positions and to control immediate actions while the battery is on the move. The low-power radios significantly enhance the battery internal communications capabilities—but only if properly utilized! All radios are subject to detection by the enemy. *Do not* allow lax communications

procedures just because the radio has low power. Train the howitzer sections to properly use radios and to smoothly change over from wire to radio in case wire communications are disrupted.

13-10. Special Situations

In field exercises, the commander should insure that personnel get the opportunity to practice setting up the intrabattery communications system *at night*. Other items that should be emphasized are—

a. *Operation of the backup system.* The unit should frequently simulate a disruption in the primary system due to counterfire, etc.

b. *Simultaneous multiple fire missions.* Both the FDC and the BOC should be drilled.

c. Use of telephones and radios while wearing a protective mask. An operator must have considerable practice in projecting his voice while wearing a protective mask.

13-11. Role of the Battery Communications Chief

With the consolidation of wire teams at the battalion level, the role of the battery communications chief becomes one primarily of advising the commander on communications matters and troubleshooting equipment and the radio and wire systems. The two switchboard operators who are left in the communications section assist in the installation and maintenance of the intrabattery wire system and operate the SB-22. The communications chief's specific responsibilities are—

a. Assisting in the training of radio operators and telephone/switchboard operators.

b. Advising the battery commander on communications considerations during selection of a battery position.

c. Monitoring the maintenance of communications equipment in the battery by making frequent spot checks.

d. Supervising the installation and monitoring the operation of the battery wire system.

e. Monitoring radio traffic to insure adherence to proper procedures and communications discipline.

f. Coordinating with the battalion communications chief on matters of personnel, communications equipment and supplies, and other support.

g. Keeping personnel informed on the proper use of the CEOI and authorized codes.

★ *h. In addition to the above-mentioned communications-related responsibilities, the communications sergeant is usually charged with supervising the maintenance of and training on the battery's mine detectors. His responsibilities should be limited to training designated operators from the firing battery in the employment and operator's maintenance of the mine detectors. The communications section is responsible for only organizational maintenance of the mine detector. As the communications sergeant receives no formal training on mine detectors, he should request assistance in establishing a maintenance/training program from the division or other engineer resources.*

CHAPTER 14

AMMUNITION PROCEDURES

Section I. INTRODUCTION

14-1. General

On the battlefield, the role of the ammunition section is one of *vital importance*. In recent years, there has been a significant proliferation of ammunition within the field artillery, and still more ammunition is being developed. Until old stocks are depleted or declared obsolete, ammunition care and handling will remain a most difficult task. It is essential that battery supervisors keep themselves up to date on the latest changes in ammunition, fuzes, propellants, and fuze setters and wrenches. References that *must* be on hand in each unit are TM 9-1300-251-20 and the appropriate weapon manual. TM 9-1300-251-20 gives technical and general maintenance information on conventional and improved conventional munitions for cannons, recoilless rifles, and mortars. Each weapon manual prescribes procedures for the handling, preparation, and maintenance of a specific caliber of ammunition as well as the procedures for operation and maintenance of fuze setters and wrenches.

Table 3-2 of TM 9-1300-251-20 gives detailed ammunition component inspection criteria, while chapter 3 explains how to correct any deficiencies noted. Appendix B contains the maintenance allocation chart, which indicates what maintenance the crew and organizational maintenance (ammunition section) are authorized to perform.

14-2. Considerations

a. In any future war, it is likely that the field artillery will be significantly outnumbered in terms of tubes. Offsetting this imbalance will require our batteries to fire considerably more ammunition per tube than does the enemy. To this undesirable situation may be added the necessity for frequent movement, possibly several times a day. Most likely, one of the battery

commander's primary concerns will be supplying the battery and distributing ammunition to the pieces.

b. TACFIRE will provide a significant advantage in offsetting the imbalance of tubes through efficient, near instantaneous management of the firing batteries. For this to happen, TACFIRE requires a continuous, accurate accounting of ammunition. To the firing battery, this means keeping the various projectiles, fuzes, and propellants segregated and keeping an accurate account of ammunition expenditures in each mission. Each cannon section checks with battery FDC and battery FDC checks with battalion FDC.

c. The battery must be capable of moving within a few minutes of notification. Keeping ammunition loaded on vehicles and servicing the howitzer directly from the ammunition vehicle are desirable. This applies to both towed and self-propelled artillery. The ammunition vehicles, then, should be habitually associated with the howitzers. This means that when a howitzer receives a scheduled maintenance, so should the ammunition vehicle; that convoys should be tactically configured so that the ammunition vehicle follows the howitzer; and that if a howitzer is dug in or revetted, the ammunition vehicle is in the same revetment.

d. Because of intense combat, battalion may have to have more control of its ammunition-carrying vehicles, and the battery commander may be required to provide security for, and radio communications with, the ammunition section. Therefore, ammunition section personnel should be trained in map reading and radio operation. They should be battery experts in ammunition and driving and should train others in these areas.

Section II. CARE AND HANDLING

14-3. General

a. A complete round of artillery ammunition contains all the components needed to get the round out of the tube and to burst at the desired place and time. The key to proper ammunition functioning is PROTECTION; from mud, heat, dampness, rough handling, fire hazards, and so on.

b. Safety is a matter of concern for all the battery personnel, and it requires special attention where ammunition is concerned. Supervision is critical, because improper care and handling can cause serious accidents as well as inaccurate fire. The following are some of the basic principles of proper ammunition handling:

(1) Never tumble, drag, throw, or drop individual projectiles or boxes of projectiles.

(2) Do not allow smoking, open flames, or other fire hazards around ammunition storage areas.

(3) Inspect each round before it is loaded for firing. Dirty ammunition can damage the weapon, cause the breech not to close, or affect the accuracy of the round.

(4) Keep the ammunition dry and cool.

(5) Never make unauthorized alterations or mix components of one lot with another. (A further discussion of lots is in paragraph 14-11.)

(6) If a round has been rammed and then must be extracted, RETURN IT to the battalion ammunition section. The rotating band (fig 14-1) or the fuze may be damaged.

(7) Leave the eyebolt lifting plug or closing plug screwed into the fuze well until the round is to be fuzed.

14-4. Projectiles

a. Each projectile must be inspected to

insure that there is no leakage of the contents, that the projectile is correctly assembled, and that the bourrelet and rotating band are smooth and free of burs and large dents. If the rotating band is burred or nicked, it should be smoothed with a flat, fine-grained file or with crocus cloth backed with a small block of wood. The rotating band grommet must be secure and tight to prevent nicking and scarring the comparatively soft rotating band.

b. High-explosive projectiles issued for use with VT fuzes are standard projectiles with the fuze booster cavities deepened to accommodate the longer VT fuze. Each of these projectiles is issued with a removable supplementary charge so that the projectile may be used with an impact, mechanical time or proximity (VT) fuze.

THE SUPPLEMENTARY CHARGE IS REMOVED ONLY WHEN THE PROJECTILE IS USED WITH A VT FUZE AND MUST BE IN PLACE WHEN THE PROJECTILE IS USED WITH A MECHANICAL TIME FUZE OR AN IMPACT FUZE.

DO NOT ATTEMPT TO REMOVE THE SUPPLEMENTARY CHARGE BY ANY MEANS OTHER THAN THE LIFTING LOOP. IF THE CHARGE CANNOT BE REMOVED BY THE LIFTING LOOP, THE ROUND MAY BE DISPOSED OF OR FIRED WITH AN IMPACT FUZE OR AN MTSQ FUZE. THE DEEP CAVITY MAY BE LINED WITH A PAPER TUBE AND BOTTOM CUP, WHICH HELP SUPPORT THE HIGH-EXPLOSIVE FILLER. THIS LINING SHOULD NOT BE REMOVED AT ANY TIME.

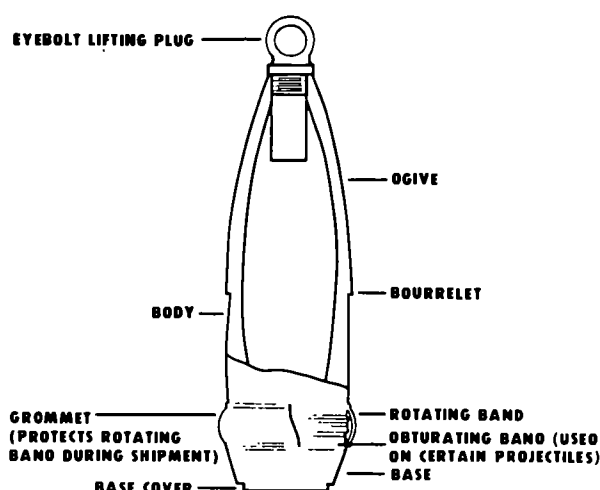


Figure 14-1. Exterior projectile parts.

14-5. Propelling Charges

a. Propelling charges, or powder, like other components of ammunition, must be kept cool and dry. Powder containers must be closed tight to keep moisture out.

b. Propellant bags must be firm, clean, and well laced or tied, and the increments must be inserted in the proper sequence. If the bags are torn or ripped, they should be turned in.

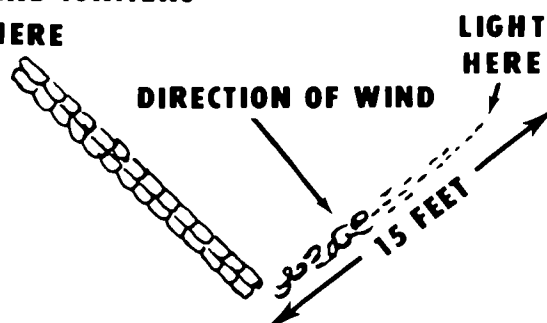
c. Do not try to save unused powder increments. They should be removed to some storage area, preferably 30 to 40 feet from the nearest weapon, until they can be burned or otherwise disposed of. If powder is to be burned, the following procedures should be followed:

(1) Select a burning site at least 200 feet from other personnel or equipment.

(2) Place charge increments in a single-layer row not more than 12 inches wide. The row should be placed so that the powder will burn *into* the wind.

(3) Lay a train of combustible material about 15 feet long, perpendicular to, and at the *downwind* end of, the row of charge increments. Light this train at the end farthest from the increments. Place igniter powder in a train not more than 2 inches wide at the *upwind* end of the increments.

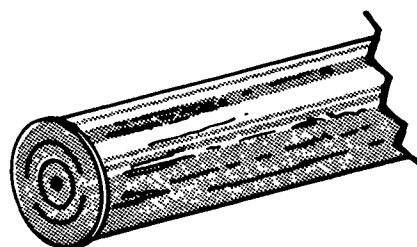
**PLACE UNUSED
FLASH REDUCERS
AND IGNITERS
HERE**



**PROPELLING CHARGES AND
IGNITER PADS SHOULD BE
SEPARATED WITH A NONSPARK-
ING INSTRUMENT TO PREVENT
THEM FROM ACCIDENTALLY
IGNITING.**

**WHEN BURNING 175-MM CHARGES,
BE SURE TO REMOVE THE CYL-
INDRICAL BAGS OF IGNITING
POWDER ("RED DEVILS") FROM
THE POLYURETHANE TUBES.**

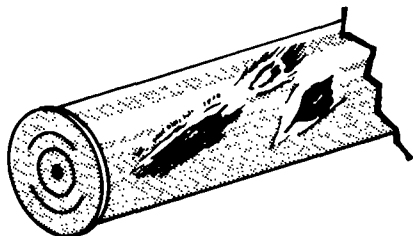
Burning powder creates a very large flash and a lot of smoke. In a tactical environment, the XO must insure that burning powder does not compromise the camouflage and concealment effort. The burning of powder in a dummy position, if established, may aid in the deception effort.



14-6. Cartridge Cases

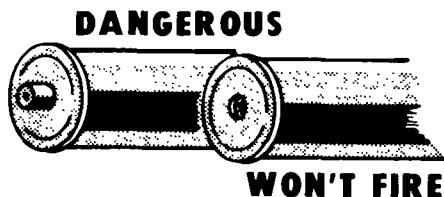
a. The cartridge case of semifixed ammunition should be checked for corrosion. Light brown staining is normal oxidation,

but black, green, yellow, or white stains mean heavy corrosion, which must be cleaned off as soon as possible.



b. Check cartridges carefully for cracks, bulges, and burs.

c. The primer must be flush with the base of the case. If it sticks out too far, it's dangerous—if it sits in too far, the round will not fire.



14-7. Fuzes

NEVER FIRE A PROJECTILE WITHOUT A FUZE THAT IS AUTHORIZED FOR THAT PROJECTILE.

a. The specific fuzes available for each weapon system are discussed in the technical manual for the weapon.

b. Fuzes are sensitive to shock and must be handled with care.

c. Before fuzing a round, inspect the threads of the fuze and fuze well for cleanliness and crossed threads.

d. The fuze should be screwed into the fuze well slowly until flush with the nose of the projectile. Using the M16 or M18 fuze wrench (as appropriate), back the fuze up one-quarter turn, then snap the fuze wrench back to secure the fuze.

NOTE. After tightening, check to insure that no gap exists between the nose of the projectile and the fuze. If a gap exists, remove

the fuze and segregate the projectile and fuze from the other ammunition until it can be inspected by service battery personnel.

PREMATURE DETONATION MAY OCCUR IF A FUZE IS NOT PROPERLY SEATED.

e. A projectile fuzed with a time fuze should not be lifted with a hand around the fuze. A slip of the hand might change the fuze setting.

f. During hailstorms or heavy rainstorms, projectiles with fuzes containing superquick elements should not be used. If they must be used, fuze settings should be changed from superquick to delay. It is possible for a fuze set on superquick to detonate when struck by hail or heavy rain.

UNITS MUST BE AWARE OF THE AMMUNITION RESTRICTIONS APPLICABLE TO THEIR CALIBER OF WEAPONS. RESTRICTIONS ARE CONTAINED IN THE WEAPON TM.

g. To prevent accidental functioning of the point-detonating elements of fuzes M564 and M548, the fuzes *must not be dropped, rolled, or struck* under any circumstances. Special care must be taken to insure that a fuzed round does not strike the breech of a weapon during loading.

h. Any mechanical time fuze that is set and not fired must be reset to **SAFE**, and the safety wires (if applicable) must be replaced before the fuze is repacked in the original carton.

14-8. Primers

a. Primers are sensitive to both shock and moisture. Primers for separate-loading ammunition should be kept away from the propellant bags and left in their sealed containers until needed.

b. Primers for semifixed ammunition are attached to the base of the cartridge case. The best way to protect them is to leave them covered with a fiber container cap until needed.

THERE ARE TWO TYPES OF PRIMERS AVAILABLE FOR SEPARATE-LOADING AMMUNITION—THE MK2A4 (FOR THE M114A1 HOW-ITZER) AND THE M82 (FOR ALL OTHERS). MAKE SURE YOU HAVE THE RIGHT ONE!

c. Inspect all primers prior to use for signs of corrosion. If a seal has been broken, it is very likely that the primer has been affected by moisture and should be turned in.

14-9. Flash Reducers

a. Some propellants burn at such a low rate that flash reducers containing black powder and potassium sulfate must be used to reduce flash at night. The flash reducers also speed up the combustion of unburned propellant gases. This helps prevent excessive muzzle blast.

b. Flash reducers absorb moisture readily, so it is critical that they be kept *dry*. Keep them off damp ground and sealed in their containers until needed for use.

c. Discarded flash reducers should be disposed of in the same manner as igniter pads (para 14-5).

FLASH REDUCERS ARE HIGHLY FLAMMABLE. IT'S CRITICAL THAT THEY BE DISPOSED OF PROPERLY TO PREVENT INJURY.

14-10. Chemical Projectiles

a. Some chemical projectiles, because of their contents, require special handling and

storage. These are the toxic chemical and the white phosphorus (WP) shells.

b. When toxic chemicals are being fired, all personnel in the area should wear protective masks, and anyone handling the shell should wear gloves. There should be an ample supply of decontaminating agents available close by in case they're needed. If possible, these shells should be stored away from other types of ammunition and downwind of the battery area.

c. The WP round should be stored upright on its base, but any time the temperature of the ammunition reaches 110° F the round *must* be stored this way. If it's not, the filler will melt and shift to one side of the cavity in the projectile, which will cause the projectile to be unbalanced. The WP shells should be in an area free of all combustibles and away from other ammunition.

14-11. Segregation of Ammunition Lots

a. Different lots of propellant burn at different rates and give slightly different effects in the target area. For this reason, the registration corrections derived from one lot do not necessarily apply to another lot. *Ammunition must be segregated by lot.*

b. The FDC will designate the lot of ammunition to be fired for each mission (or it will be standardized), so the lot designator should be prominently displayed for each stack of ammunition.

c. In the field storage area, be it on vehicles or in a dump, lots of ammunition should be roped off with communications wire or twine and conspicuously marked with a cardboard sign or some such marker.

Section III. FIELD STORAGE OF AMMUNITION

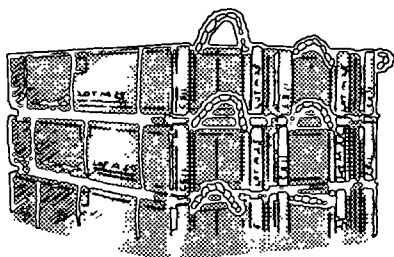
14-12. Hazards

a. The four greatest hazards to ammunition in the battery area are:

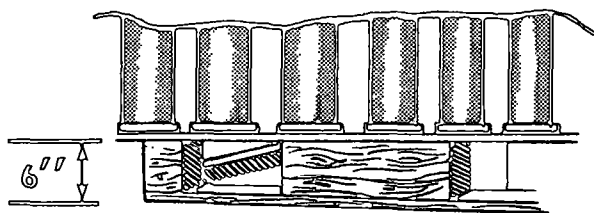
WEATHER,
ENEMY FIRE,
IMPROPER HANDLING,
and
CARELESS SMOKERS,
CO,

regardless of the method of storage, these hazards must be given consideration. Specific storage techniques are discussed later in this section, but here are some general considerations:

(1) Stack ammunition by type, lot number, and weight zone.



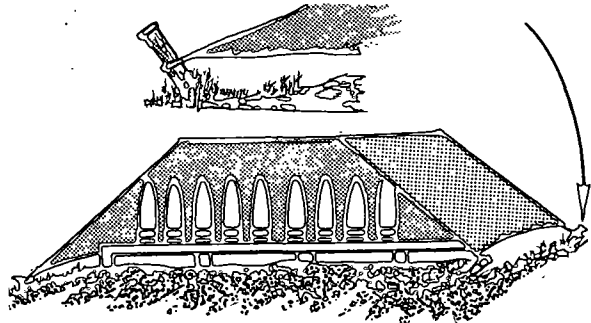
(2) If ammunition is being stored on the ground, use good strong dunnage at least 6 inches high under each stack.



(3) Keep the ammunition dry and out of direct sunlight by storing it in a vehicle or covering it with a tarp. Be sure adequate ventilation is provided.

(4) Provide ammunition, if offloaded, as much protection from enemy indirect fires as time and available materials allow. If sandbags are used for protection, keep the walls at least 6 inches from the stacks and the roof at least 18 inches from the stacks to insure proper ventilation.

PAULIN COVER
SECURELY STAKED



b. Particular attention must be paid to ammunition temperature. Most ammunition components can be stored at temperatures as low as -80°F for periods of not more than 3 days and as high as $+160^{\circ}\text{F}$ for periods of not more than 4 hours per day. An increase in malfunctions may be experienced with some VT fuzes when the temperature is below 0° or above 120°F . Powder temperature affects the muzzle velocity of a fired round and is a matter of frequent concern to the FDC. At least two howitzer sections should be designated to keep track of the powder temperature. A powder thermometer is inserted into the top powder increment in the canister, and care must be exercised to insure the thermometer does not touch metal.

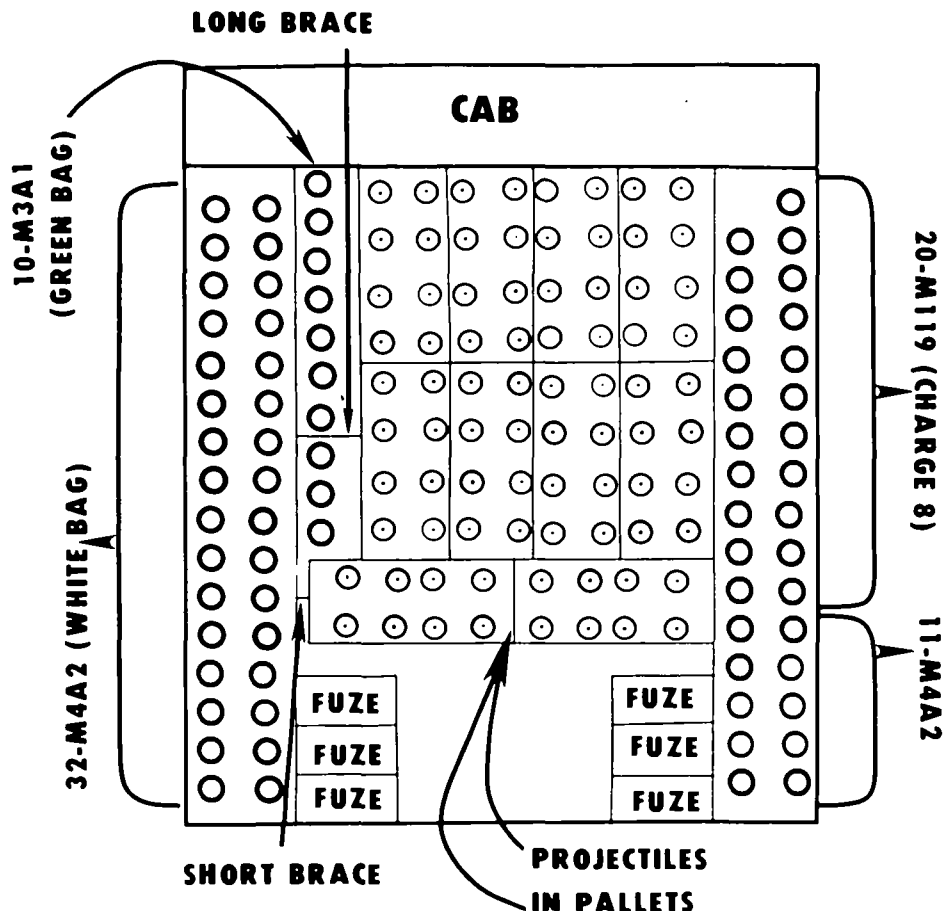
CANNON SECTIONS MUST BE
CAREFUL NOT TO FIRE THE
POWDER THERMOMETER.

c. Only enough ammunition to meet current needs should ever be prepared at the pieces.

14-13. Storage Techniques

a. In SP units, the M548 cargo ammunition carrier is the companion vehicle to the howitzer and serves as an excellent area from which to service the weapon as well as a storage area for ammunition. Normally, the M548 should be positioned with its howitzer and replenished in the battery area by the ammunition section. Figure 14-2 shows a suggested method of loading the M548 for an

M109-series howitzer section. Loading diagrams for other howitzer systems are in chapter 2 of the M548 operator's technical manual.



Notes.

1. Powder charges must be secured in the upright position.
2. Tiedowns over the top of ammunition pallets and secured to the floor of the carrier (to existing brackets) will keep the load from shifting.
3. Powder mix is arbitrary and will vary from unit to unit, depending on the tactical situation.
- ★ 4. Load indicated is for an M109-series howitzer section.

Figure 14-2. A typical M548 ammunition bed.

Ammunition should be left in pallets until needed for use. Figures 14-3 and 14-4 show recommended methods of securing the ammunition.

**BE SURE PALLETS ARE ADE-
QUATELY CRIBBED AND
SECURED TO PREVENT THEM
FROM SHIFTING DURING
MOVEMENT.**

b. In order to increase the ammunition-carrying capability of cannon batteries, additional M332 ammunition trailers are required in the TOE. Although some degradation in mobility may occur, an M332 trailer should be pulled by each of the following ammunition vehicles currently shown in various TOE: The 6-ton cargo carrier, the 2½- and 5-ton trucks, and the 8-ton GOER. These 1½-ton trailers can—

- (1) Increase organic hauling capability,

★ MATERIALS

- ① 2 pieces angle iron $\frac{1}{4}$ " x 2" x $1\frac{1}{2}$ " x 10'8" (top)
2 pieces angle iron $\frac{1}{4}$ " x 2" x 2" x 10'4" (bottom)
- ② 4 pieces angle iron $\frac{1}{4}$ " x 2" x 16"
- ③ 4 pieces angle iron $\frac{1}{4}$ " x 2" x 12"
- ④ 14 pieces strap iron $\frac{1}{4}$ " x $1\frac{1}{2}$ " x $3\frac{1}{2}$ "
- ⑤ 6- $\frac{1}{2}$ " x $1\frac{1}{2}$ " capscrews with lockwashers
- ⑥ 4-4 $\frac{1}{2}$ " to 5" butt hinges

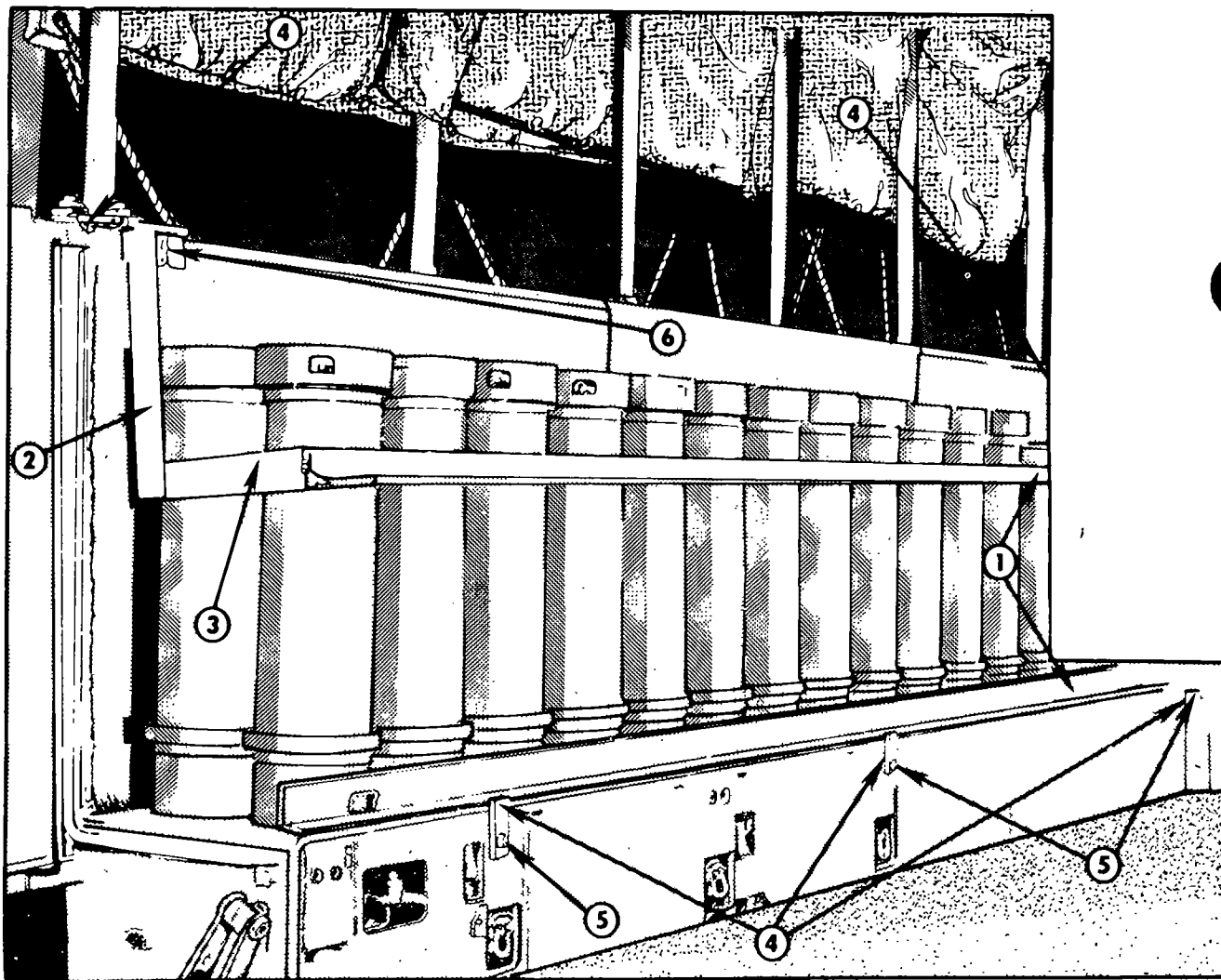
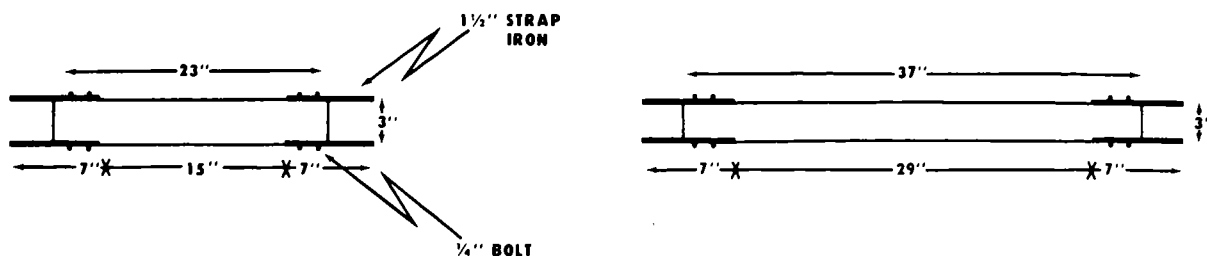


Figure 14-3. Canister holddown brackets.



These braces should be used with the full load shown in figure 14-2. The short brace is used for three pallets and the long one for two. When either type of brace is used, the pallet top will be fitted between the strap iron brackets in the 3-inch gap. Two braces will be used between pallets.

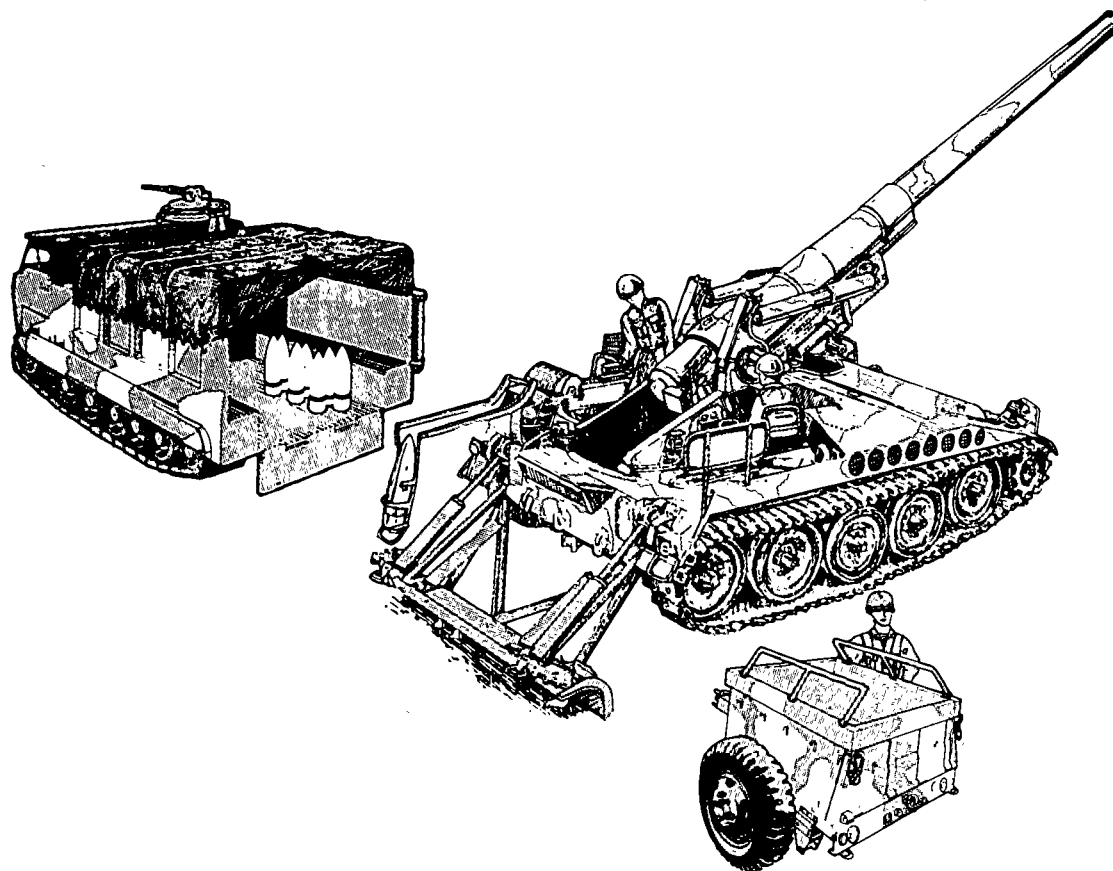
Figure 14-4. Pallet braces for securing ammunition pallets.

(2) Facilitate resupply and backhaul operations, and

(3) Permit ammunition component segregation (to reduce the battery's vulnerability to counterfire).

c. In towed units, the prime mover, loaded with ammunition, should be positioned near

the howitzer. Ammunition should be left loaded until it is prepared for firing. Other ammunition is stored on the battery ammunition section vehicles, or at a battery ammunition dump. The establishment of a battery ammunition dump is a matter of command decision, because it *seriously* impairs the mobility of the battery.



Section IV. MISCELLANEOUS

14-14. Accidents

Generally, firing accidents are serious in nature, so all supervisory personnel should know the immediate action to be taken. Here are some general guidelines for use in the development of a sound SOP:

- a. Render first aid to injured personnel; then call for medical assistance.
- b. If the ammunition or equipment presents further danger, move all personnel out of the area.
- c. Do not change any settings on, or modify the position of, the weapon in any way until an investigation has been completed.
- d. Record the lot number of the ammunition involved in the accident or malfunction and report it to the battalion ammunition officer. If there is good reason to suspect a particular lot of ammunition, its use should be suspended by the XO.

14-15. Misfire Procedures

Misfires *do* occur, and when they do, there are specific things that must be done within specific time limits. For that reason, personnel must be thoroughly familiar with

★the misfire procedures for their weapon system. These procedures are in the appropriate weapons technical manuals (TM).

14-16. Training

a. Ammunition training has traditionally been a weak area. Cannoneers seldom get to practice setting time fuzes or cutting propellant charges until the battery goes to the field to conduct live firing. There are several training extension course (TEC) lessons on ammunition to enhance individual training. Additionally, your Training and Audiovisual Support Center (TASC) has an excellent selection of ammunition training materials.

b. Collective training can be enhanced by the use of training rounds, which are available through the local training aids office. New training rounds are constantly being introduced into the training aids inventory. These rounds are designed to exercise the entire howitzer crew—from loading, cribbing, and handling ammunition to setting fuzes, cutting charges, loading, and firing. Keep an up-to-date TASC catalog and take advantage of these devices. More tips on training ammunition section personnel are found in chapter 17.

CHAPTER 15

DUTIES OF SAFETY PERSONNEL DURING SERVICE PRACTICE FIRING

Section I. INTRODUCTION

★15-1. General

a. It is the principal duty of the leaders of the firing battery to prepare their unit in peacetime to perform its mission in combat. Today's training philosophy is to train as we will fight and to emphasize realistic, meaningful, and safe training. In the past, the concern for safety has resulted in artificial peacetime requirements, to the detriment of realism.

b. Perhaps in no other branch of the Army is safety more critical than in the field artillery. The effect of even the smallest of errors can be serious. In peacetime, a single round "fired out" can result in loss of life, injury, or damage to property among the civilian or military community. In combat, it can cause friendly casualties and destroy the feelings of trust and confidence the field artillery enjoys among the members of the combined arms team.

c. The importance of safety is well recognized. However, an inordinate concern for safety can be counterproductive to the goal of realistic combat training. In the past, a safety officer insured that proper procedures were followed and that all data was safe before a weapon was fired. Usually, this safety officer was a junior officer, not assigned to the unit for which he was performing safety duties. The safety officer was strictly a peacetime requirement and a luxury that could not be afforded in war. Hence, the problem: We trained units with safety officers but expected the units to rapidly deploy to combat without them. The solution is to train the battery to perform its combat mission without relying on an asset that will not be available during combat.

d. AR 385-63, *Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat*, chapter 11, implements the chain-of-command safety

concept. Under this concept, the firing battery chain of command is responsible for safety during firing—in training or in combat. This chapter reinforces AR 385-63. However, if local range regulations are more restrictive than the material in this chapter, the local range regulations must be followed. The responsibilities for safety are fixed as follows:

(1) *Safety training and certification program.* Commanders of field artillery units will establish and maintain a safety training and certification program for their personnel. The purpose of this program is to train and qualify individual members of the firing battery in the safety procedures for their specific areas of responsibility. When the responsible artillery commander is satisfied, through the use of intensive training and testing programs, that the individual members are qualified to perform the safety duties as required in the firing battery, he certifies them as competent to perform those duties. Command safety certification programs should be reviewed and approved by a full-time safety manager.

(2) *Battalion commander.* The field artillery battalion commander is responsible for safety during all phases of a firing exercise under his control. The commander selects, trains, and certifies the personnel necessary to assist him in discharging this responsibility. These personnel include, but are not limited to, the firing battery commander, executive officer, assistant executive officer/fire direction officer, chief of firing battery, gunnery sergeant, FDC chief computer, and gun/howitzer chief of section. If any position is not filled by a command safety certified individual, another individual who is certified and qualified to fill that position performs the safety checks.

(3) *Officer in charge.* The OIC is the battery commander or his command safety certified direct representative. The OIC is

responsible for all aspects of safety in the firing unit and on the assigned firing range. Before the firing exercise starts, the OIC will be provided the required safety data and firing limitations by the range control officer. The OIC verifies that the unit is in the proper firing position. He supervises the conversion of the safety data into a safety diagram and insures that this diagram is verified by another command safety certified individual. The safety diagram provides right and left deflection limits, minimum and maximum quadrant elevations for authorized charges, and minimum safe fuze times. The safety diagram is provided, modified as necessary by the XO's min QE, to the appropriate members of the firing battery.

(4) *Executive officer.* The firing battery executive officer is responsible for the safety practices of the firing battery. He is assisted in his duties by the chief of firing battery and/or the gunnery sergeant.

(5) *Assistant executive officer/fire direction officer.* The AXO/FDO has primary responsibility for computing the safety diagram from the safety data and for insuring all safety diagrams are updated after registrations and receipt of current meteorological data. He is assisted in his duties by the chief computer. He insures all firing data are within prescribed safety limits before they are transmitted to the firing sections.

(6) *Chief of firing section.* The chief of firing section is responsible for insuring that only safe practices take place at or near his weapon, to include verifying that the announced and proper data are applied to his weapon and that the proper charge, fuze, and projectiles are fired. He has the final responsibility for the firing of his weapon.

(7) *Range control officer.* The range control officer (RCO) provides the OIC of firing with the following safety data: the grid coordinates of the firing position, the lateral safety limits, the minimum and maximum ranges, authorized ammunition to be fired (fuze, projectile, and charge), trajectory (high angle or low angle), target locations, and the hours during which the firing may be conducted.

☆15-2. Duties of the Safety Officer

☆ *a.* A separate battery safety officer is not required during the firing of field artillery. However, a commander may use a safety officer if his unit's state of training or lack of safety certified personnel so dictates. The battery safety officer must be a command safety certified direct representative of the OIC. The battery safety officer will be provided safety data by the OIC. The battery safety officer makes safety checks to insure that only the authorized ammunition is fired (fuze, projectile, propellant), that the rounds land within the designated impact areas, and that no unsafe practices take place at or near the weapon(s). The battery safety officer is not required to verify all data placed on the on-carriage fire control equipment. He may rely on safety stakes, safety tape, or physical constraints on the weapon to insure that the safety limits are not exceeded. The safety officer must be thoroughly familiar with five references: AR 385-63, FM 6-50, TM 43-0001-28, the appropriate TM for the weapon, and local range regulations. His specific duties are as follows:

(1) Before firing—

(a) Verify that the data provided by the range control officer to the OIC apply to the unit firing, that the unit is in the correct location, and that the data are correct.

(b) Verify the safety diagram (para 15-4).

(c) Check the weapons for correct boresighting.

(d) Verify the lay of the battery.

(e) Verify the minimum quadrant elevation determined by the executive officer.

(f) Compare the XO's minimum QE with the quadrant elevation for minimum range shown on the safety diagram, and use the larger of the two as the minimum QE.

(g) Supervise and check the emplacement of safety aids (stakes, safety tape, and other devices).

(h) Verify that the ammunition to be fired is of the type specified on the safety card.

(i) Insure that the chiefs of section are informed of maximum and minimum quadrant elevations, right and left deflection limits, and minimum fuze settings.

(j) Verify that range clearance has been obtained by checking with the officer in charge of firing.

(k) Ascertain or confirm that the visible portion of the impact area is clear of personnel.

(l) Insure compliance with Department of the Army regulations, local range regulations, and local special instructions pertaining to safety. When the checks required before firing have been made, the safety officer informs the OIC that it is safe for the battery to fire.

(2) *During firing—*

(a) Verify the serviceability of ammunition.

(b) Insure that the charges, projectiles, and fuzes being fired are only those prescribed on the safety card.

(c) Insure that rounds are not fired below the minimum quadrant elevation or above the maximum quadrant elevation.

(d) Insure that rounds are not fired outside the lateral safety limits specified on the safety card.

(e) Insure that time-fuzed rounds are not fired with fuze settings that are less than the minimum time prescribed on the safety diagram.

(f) Require that unused powder increments be displayed for each round to be fired.

(g) On all commands that are unsafe to fire, command UNSAFE TO FIRE and give the reasons. Examples are:

UNSAFE TO FIRE
3 MILS OUTSIDE RIGHT
SAFETY LIMIT AND 20 MILS
ABOVE MAXIMUM
QUADRANT ELEVATION.

UNSAFE TO FIRE
5 MILS BELOW MINIMUM
QUADRANT ELEVATION.

(h) Apply registration corrections to the safety limits immediately after registration.

(i) By a positive act, such as a hand signal or a voice command, indicate to the chief of section when it is safe to fire.

(j) Report accidents and malfunctions of ammunition to the officer in charge of firing and make those reports required by local range regulations and AR 385-63.

(k) Bring to the attention of the OIC any unsafe conditions observed and suspend firing until these conditions have been corrected. Examples of unsafe conditions are:

Safety features of the weapon not operable.

Powder bags exposed to fire.

Personnel smoking near pieces.

Improper handling of ammunition.

Time fuzes previously set and not reset to safe.

Personnel or aircraft directly in front of the weapons.

Primer inserted into the firing assembly before breech is closed (separate-loading ammunition).

Failure to inspect powder chamber and bore after each round is fired.

Failure to swab powder chamber after each round of separate-loading ammunition is fired.

★ Misfires (para 14-15). The safety officer must insure that the cannon personnel follow the prescribed misfire procedures.

b. The safety officer performs his duties in a manner that insures compliance with all safety regulations and limits; however, he should not use procedures that will unnecessarily delay the delivery of fire.

★15-3. Safety Aids

★ *a.* A number of visual aids can be used to verify that howitzers are laid within safety limits. Two such aids are safety stakes (towed weapons) and safety tape (M109 and M109A1/M109A2/M109A3 howitzers). These aids, each of which is discussed below, may be used as guides for any deflection (and quadrant on the M109-series weapons) not within 20 mils of a safety limit. If a safety officer is appointed and a deflection announced is within 20 mils of a limit, the safety officer should go to the piece and verify sight settings.

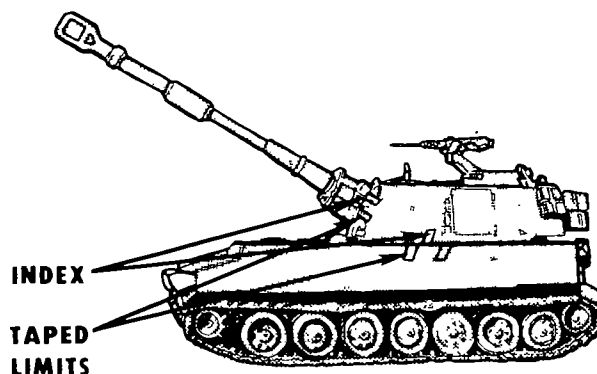
b. To emplace safety stakes—

(1) Set on the sight, in turn, the left, intermediate, and right deflection limits and take up a proper sight picture on the collimator or aiming posts.

(2) Sight through the breech end of the tube and, sighting along the left edge of the tube for the left limit and the right edge of the tube for the right limit, align the safety stakes. They should be firmly driven into the ground approximately 10 feet in front of the tube.

c. Safety tape provides a convenient and fast method of verifying firing data on the M109/M109A1 weapons. As shown in figure

★15-1, an index is placed on the movable portion of the hull. Then the weapon is traversed to the left and right limits, and at each limit a piece of tape is placed on the lower hull under the index. By the same method, tape can be placed on the tube and on the front of the upper hull to indicate elevation limits.



★Figure 15-1. Safety tape.

d. From the range safety card, the FDO prepares a safety diagram and a safety "T" for the safety officer/NCO. The safety "T" is a convenient method of arranging the safety data. A 3 inch x 5 inch card may be used. Here is the safety "T" for the data computed in section II of this chapter.

(Maximum QE)

(Deflection limits)

(Minimum QE Ti & VT)

(Minimum FS M564)

(Minimum FS M514)

(Minimum FS M501)

(Minimum QE PD)

(Minimum QE WP)

CHG 4 GB

	299	361	
3570	3270	2850	
	123	Min QE Ti & VT	
	7.9	M564	
	13.0	M514	
	8.3	M501	
	115	Min QE Q	
	126	Min QE WP	

★ Section II. COMPUTATION OF SAFETY DATA

★15-4. Construction of the Basic Safety Diagram

A basic safety diagram is a rough graphical representation of the data on the safety card. Prior to registration, the FDO must construct the basic safety diagram using the following procedures:

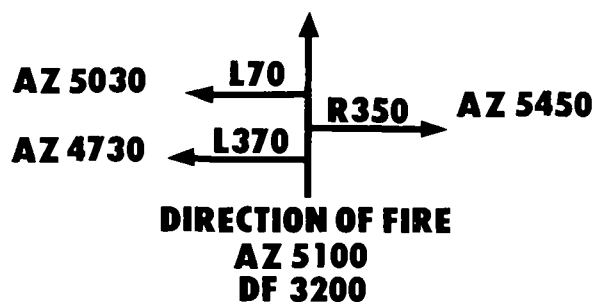
a. To determine the deflection limits—

(1) On a sheet of paper draw a line representing the lay of the battery (initial direction of fire) (fig 15-2). Label this line with its azimuth and the common deflection.



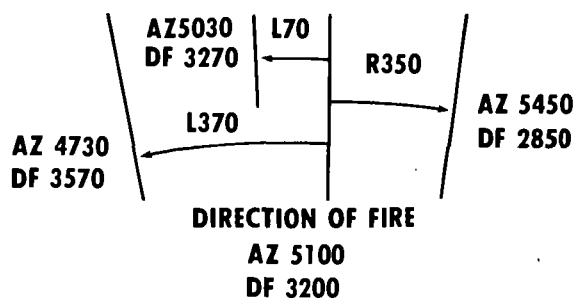
★ Figure 15-2. Direction.

(2) Compute the angular measurements to the right and left safety limits by comparing the azimuth on which the battery is laid (given by the battery commander) with the azimuths of the right and left limits. Draw and label arrows indicating the angular measurements as shown in figure 15-3.



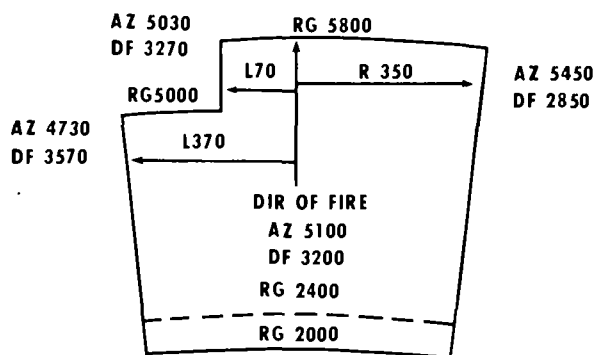
★ Figure 15-3. Angular measurements.

(3) Draw lines representing the lateral limits in proper relation to the line on which the battery is laid. Apply the angular measurements to the deflection corresponding to the direction of fire to determine the deflection limits; use the "LARS" rule (Left, Add/Right, Subtract). Label the deflection limits (fig 15-4).



★ Figure 15-4. Deflection limits.

b. Draw arcs between the lateral safety limits to represent the minimum and maximum ranges. Label each arc with the appropriate range. A completed basic safety diagram is shown in figure 15-5.



★ Figure 15-5. Basic range safety diagram.

★15-5. Safety Data for Shell HE

a. After the basic safety diagram has been drawn on a sheet of paper, it must be constructed on a map of the impact area using a range deflection protractor (RDP). These limits must be drawn accurately, because they will be used to determine altitudes for vertical intervals. Determine the highest altitude on the minimum range line. This will be used to insure that, regardless of the deflection fired, the round will clear the highest point and land within the impact area. At the maximum range, select the minimum altitude to insure that the round will not clear the maximum range.

NOTE: THE RULE FOR DETERMINING THE CORRECT ALTITUDE FOR SAFETY PURPOSES IS CALLED THE "MINI-MAX" RULE: AT THE *MINIMUM* RANGE SELECT THE *MAXIMUM* ALTITUDE ON THE *MINIMUM* RANGE LINE; AT THE *MAXIMUM* RANGE SELECT THE *MINIMUM* ALTITUDE ON THE *MAXIMUM* RANGE LINE.

If the contour interval is in feet, either the GST or a feet-to-meters conversion table must be used to convert the altitude to meters.

b. Determine the *vertical interval* by subtracting the battery altitude from the altitude of the applicable range line. The vertical intervals for this problem have been determined in the following manner:

(1) From the diagram constructed in accordance with *a* above, determine the following altitudes:

(a) Maximum altitude at minimum range 2000 = 411 M

(b) Maximum altitude at minimum range 2400 = 380 M

(c) Minimum altitude at maximum range 5000 = 409 M

(d) Minimum altitude at maximum range 5800 = 406 M

(2) The battery altitude is 390 M (scaled from map or determined by survey).

(3) Compute the vertical intervals:

(a) Minimum range 2000: 411-390 = +21 VI

(b) Minimum range 2400: 380-390 = -10 VI

(c) Maximum range 5000: 409-390 = +19 VI

(d) Maximum range 5800: 406-390 = +16 VI

c. To determine minimum quadrant elevation (min QE):

(1) For each charge, algebraically add the elevation for the minimum range to the site at the highest altitude along the minimum range line.

(a) Determine elevation to the nearest mil by using the GFT whenever possible. For ranges not shown on the GFT, use the tabular firing table (TFT). Express the elevation to the nearest mil.

(b) Determine site to the nearest mil by using the GST site-range scales whenever possible. For ranges not shown on these scales, use the tabular firing table. In this case, determine the angle of site by using the C and D scales on the GST. Determine the comp site factor by entering table G of the TFT. (If the range is not listed, enter table G with the next higher listed range.) After extracting the comp site factor from table G, multiply it by the angle of site. The result is the complementary angle of site. To determine site, add the angle of site to the complementary angle of site.

(2) Example: Minimum QE for impact fuze minimum range—

Vertical interval (411-390)	= +21 meters
Angle of site (GST = +21/2000)	= +10.7
Comp site (0.010×10.7)	= 0.1
Site	= +11
Elevation for 2000 meters (GFT) Chg 4 GB	= 104
Minimum quadrant elevation	= 115 mils

(3) Example: Minimum QE for time fuze minimum range—

Vertical interval (380-390)	= -10 meters
Angle of site (GST = -10/2400)	= -4.2
Comp site (-0.01×-4.2)	= 0.0
Site	= -4.2 = -4
Elevation for 2400 meters (GFT) Chg 4 GB	= 127
Minimum quadrant elevation	= 123 mils

d. To determine maximum quadrant elevation (Max QE):

(1) For each charge, algebraically add the elevation for the maximum range to the site at the lowest altitude along the maximum range line.

(2) Example: Maximum QE (left segment)—

(a) Using the maximum range, determine the elevation as described in c(1)(a) above.

(b) Using the maximum range, determine site as described in c(1)(b) above. Use GST site-range scales whenever possible.

(c) Apply site to elevation to determine maximum QE:

Vertical interval (409-390)	= +19 meters
Site (GST)	= +4
Elevation for 5000 meters (GFT)	= 295
Maximum quadrant elevation	= 299 mils

(3) Example: Maximum QE (right segment)—

Vertical interval (406-390)	= +16 meters
Site (GST)	= +3
Elevation for 5800 meters (GFT)	= 358
Maximum quadrant elevation	= 361 mils

e. Minimum fuze settings (Min FS) are as follows:

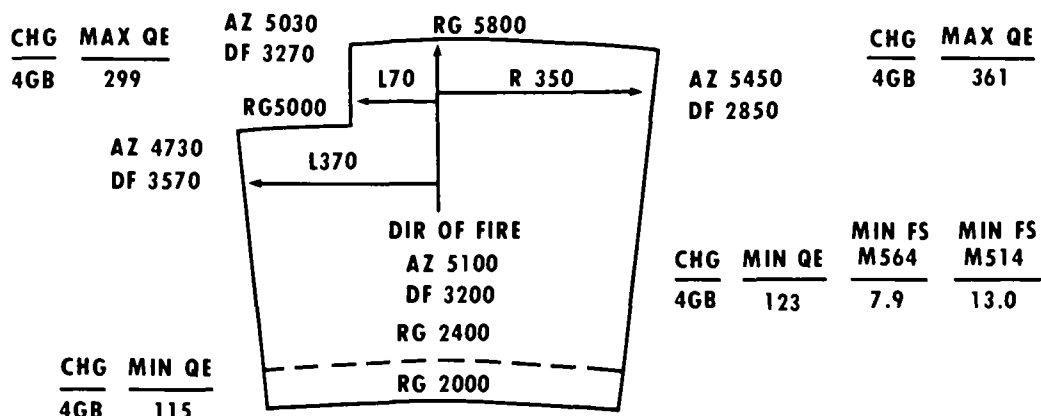
(1) Fuze M564. The minimum fuze setting for fuze M564 is that setting corresponding to the elevation for the minimum time range. This may be the same range listed for fuze quick. If only one minimum range is listed on the range safety

card, that range will be used for all fuze types. Before registration, the fuze setting is determined by placing the manufacturer's hairline over the range and reading the corresponding fuze setting from the GFT. The TFT may be used to determine the fuze setting by entering the TFT with range and extracting the corresponding value in the "FS for graze burst M564" column of table F. Insure that the time of flight is not extracted, since the fuze setting for M564 and time of flight (in seconds) are not necessarily the same.

Example: Minimum fuze setting (M564)—

Elevation for minimum range (2400M)	= 127
Minimum fuze setting for fuze M564	= 7.9

★ (2) Fuzes M513, M514, and M728 (VT). The minimum fuze setting for proximity (VT) fuzes M513, M514, and M728 is the time of flight corresponding to the elevation for minimum range plus 5.5 seconds. The result is rounded up to the next higher whole second. The time of flight is obtained by entering table F of the TFT with the minimum range and extracting the corresponding time of flight. Range is used as the entry argument because elevation and range correspond prior to registration, and range is the more convenient element to use. The fuze time minimum quadrant is used for the minimum quadrant of a round with VT fuze.



★ Figure 15-6. Completed safety diagram prior to registration.

Example: Minimum fuze setting (M514)—

Elevation for minimum range (2000M)	= 104
Time of flight (from TFT)	= 6.6
Plus 5.5 seconds	= 5.5
	12.1 = 13.0
Minimum fuze setting for fuze M514	= 13.0

★ *f. Computation of minimum and maximum quadrant elevations and the minimum fuze settings completes the basic safety diagram prior to registration. See figure 15-6. Maximum fuze settings are not determined, since rounds fired at the maximum quadrant elevation will impact within the designated area even if the fuze setting is too great.*

NOTE: SAFETY DATA COMPUTED AS SHOWN IN PARA 15-5 IS FOR THE STANDARD WEIGHT HE PROJECTILE. IF YOU ARE FIRING OTHER THAN THE STANDARD, A WEIGHT CORRECTION FACTOR MUST BE APPLIED WHEN COMPUTING SAFETY DATA. SEE PARA 15-9.

★15-6. Safety Diagram After Registration

After a registration has been fired and corrections have been obtained, the FDO modifies the original basic safety diagram by applying the registration corrections. He changes the elevations on the basis of the GFT setting obtained from the registration, and alters the deflections for the lateral limits by the amount of the total deflection correction. The following elements and computations are involved:

a. Deflection. Determine the deflection limits by applying the total deflection correction to the deflection limits of the basic safety diagram.

b. Quadrant elevation. The minimum quadrant elevation is the sum of the site and elevation for the minimum range; the maximum quadrant elevation is the sum of the site and elevation for the maximum

range. Compute quadrant elevation as follows:

(1) After registration, construct the GFT setting on the GFT and read the elevations for minimum and maximum ranges under the elevation gage line.

(2) Use the site computed prior to registration.

(3) Add the new elevation to the already computed site to obtain the quadrant.

c. Minimum fuze settings.

(1) After a time registration has been conducted, the minimum fuze setting for time fuzes is the fuze setting corresponding to the minimum elevation (*b*(1) above) plus the fuze correction determined from registration. On the GFT, read the minimum fuze setting under the time gage line.

(2) Determine the fuze setting for a VT fuze by reading the time of flight in the TFT corresponding to the elevation determined in *b*(1) above or the next higher listed elevation, adding 5.5 seconds, and then rounding the results to the next higher whole second.

d. Example: Safety diagram after registration—

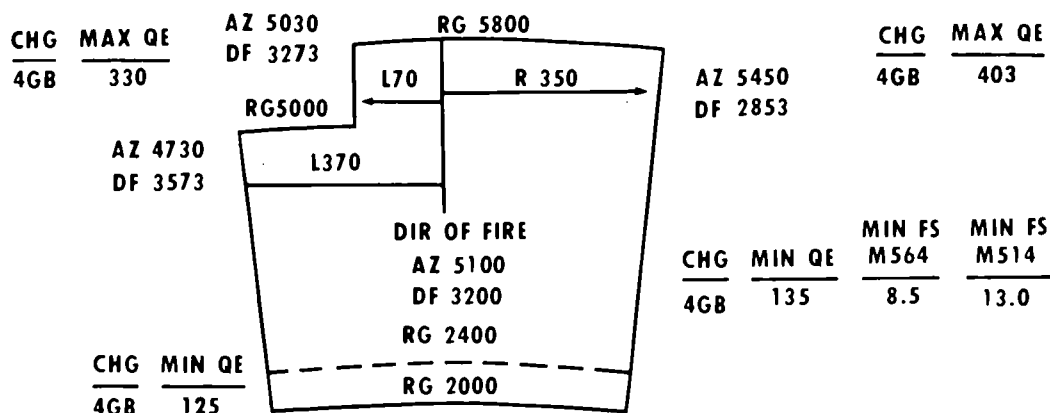
(1) *Situation.* Assume that you have conducted a registration and obtained the following GFT setting and deflection correction: GFT B: Chg 4, lot WS, rg 4400, el 277, ti 16.7 and total deflection correction L3.

★ Figure 15-7 shows the basic safety diagram (fig 15-6) modified by the amount of the registration corrections.

(2) *Deflection after registration.* Apply L3 to all deflections computed prior to registration.

(3) *Minimum quadrant elevation.* If the GFT does not extend to the minimum range, compute a range K (see FM 6-40) and apply it to the minimum range to determine a corrected minimum range. The minimum quadrant elevation is the tabular firing table elevation corresponding to the corrected minimum range plus the site computed prior to registration.

Example: Minimum quadrant elevation—



★ Figure 15-7. Safety diagram after registration.

Minimum range = 2000 meters
 Elevation for range = 114
 Site = +11
 Minimum quadrant elevation (2000 meters) = 125

Minimum range = 2400 meters
 Elevation for range = 139
 Site = -4
 Minimum quadrant elevation (2400 meters) = 135

(4) *Minimum FS—fuze M564.*

Fuze setting corresponding to minimum elevation (el 139) = 8.5

(5) *Minimum FS—fuze M514.*

Time of flight corresponding to corrected minimum elevation (el 114) = 7.3
 Plus 5.5 seconds = 5.5
 Total = 12.8
 Minimum FS—fuze M514 = 13.0

(6) *Maximum quadrant elevation—range 5000.*

Elevation range 5000 meters (GFT) = 326
 Site = +4
 Maximum QE = 330

(7) *Maximum quadrant elevation—range 5800.*

Elevation for range 5800 meters = 400
 Site = +3
 Maximum QE = 403

★15-7. Safety Data for Shell ICM

a. Safety data for shell ICM, except the 155-mm M483A1 projectile, are computed by using the appropriate HE TFTs and ICM addendums. Data for this round are computed by using the M483A1 TFT and its associated ICM addendum.

b. To determine deflection limits for shell ICM:

(1) Compute deflection limits as shown in paragraph 15-4a.

(2) Compute a deflection correction factor (in mils) which will decrease the deflection limit of the safety diagram by 100 meters at the minimum range line. To do this, use the mil relation formula, which states:

An angle of 1 mil will subtend a width of 1 meter at a distance of 1,000 meters.

The relation is expressed as $\mu = \frac{W}{R}$,

where μ is the angular measurement in mils, R is the distance in thousands of meters (expressed to the nearest hundred meters), and W is the width in meters.

An example of the computation of the shell ICM deflection correction follows:

Range to the minimum range line is 5,500 meters, and the desired correction is 100

meters. Therefore, $R = 5.5$ (minimum range line expressed in thousands of meters to the nearest hundred meters) and $W = 100$ (desired correction). To determine the correction factor (ρ), solve the mil relation formula: $\rho = \frac{100}{5.5} = 18.18$, which is expressed to the next higher whole number. Therefore, 19 is the deflection correction factor.

(3) Subtract the deflection correction ((2) above) from the left deflection limit, and add the deflection correction ((2) above) to the right deflection limit.

b. To determine the minimum quadrant elevation and fuze setting—

(1) Add 100 meters to the minimum range line. This becomes the minimum range for shell ICM safety computations.

(2) Enter the appropriate TFT with range determined in (1) above, and extract corresponding elevation.

(3) Compute site by using the maximum altitude at the range in (1) above.

(4) Use elevation ((2) above) plus site ((3) above) as the QE value to enter the ICM addendum and determine the shell ICM correction factor.

(5) Determine fuze setting for graze burst at range from (2) above in the appropriate TFT.

(6) Enter the ICM addendum with QE ((4) above) and fuze setting ((5) above).

(7) Determine correction to QE from appropriate column in table A.

(8) Determine correction to fuze setting from table B.

(9) Add correction from (7) and (8) above to QE (4) and FS (5) for minimum safe data.

c. Safety data for the M483A1 projectile fired in the self-registration mode are computed in the same manner as HE safety data, except the M483A1 TFT or GFT are used.

d. To determine maximum quadrant elevation—

(1) Enter the range to impact column (far right column) in the appropriate ICM addendum with the range to impact that does not exceed the maximum safe range.

(2) Extract the QE from column 1 of the addendum that corresponds to the range in paragraph (1) above.

(3) Determine the correction factor corresponding to the range in (1) above for the projectile being fired.

(4) Determine site for the minimum altitude at the maximum range line for the shell being fired.

(5) Add the QE ((2) above) and the correction factor ((3) above), and apply site ((4) above) to the sum. The resulting value is the maximum quadrant elevation.

e. A maximum safe fuze setting is not required nor determined.

★15-8. Safety Data for High-Angle Fire

The safety diagram for high-angle fire is computed in the same general manner as that for low-angle fire except for the peculiarities created by the trajectory of high-angle fire. The exceptions are as follows:

a. Deflection.

(1) Prior to registration. The deflection limits for high-angle fire are computed in the same manner as those for low-angle fire, except that the limits are modified by the large amount of drift peculiar to high-angle fire. The left deflection limit is moved to the left by the amount of the minimum high-angle drift for the charges to be fired within the range limits. The right deflection limit is moved to the left by the amount of maximum drift for the charges to be fired within the range limits. The values for minimum and maximum drift are obtained from the GFT. If the drift value is not listed on the GFT for the ranges (minimum and maximum) listed on the safety card, the nearest value in the TFT is used.

(2) After high-angle registration. The deflection limits for high-angle fire are computed in the same manner as those for low-angle fire and are further modified as noted in (1) above. Since the elevation will

change after registration, drift must be recomputed. Registration corrections for charges 1 through 4 can be transferred to any other of charges 1 through 5; however, corrections for charge 5 and above apply only to the charge registered.

b. Quadrant elevation.

(1) Prior to registration. The minimum and maximum quadrants for high-angle fire are handled in the same manner as those for low-angle fire except for the computation of site. The 10-mil site factor from the GFT is used, and the angle of site is computed to the nearest whole mil from the GST by use of the M-gagepoint.

(2) After high-angle registration. The firing of missions throughout the safety limits usually will require more than one charge; therefore, the minimum and maximum elevations are computed for each charge using the corrections determined for the charge registered. The minimum and maximum elevations for high-angle fire are computed in the same manner as those for low-angle fire. If a GFT is to be used, the minimum and maximum elevations are read under the manufacturer's hairline. Site must be recomputed by use of the 10-mil factor as described above.

c. Fuze settings. Minimum fuze settings are not computed for high-angle fire. Mechanical time fuzes should not be used due to excessive probable errors in height of burst. For safety in firing high-angle with fuze VT, the FDO must insure a safe target plot and correct computation of fuze setting.

★15-9. Safety Data for Shell Smoke (WP, HC, and Colored)

a. The weight of all projectiles is usually stamped on the projectile in terms of so many squares ($\square$). Each caliber HE projectile has a designated standard $\square$ weight. The standards are listed in the introduction to the appropriate TFT. The TFT data is based on the standard weight projectile. Therefore, any time we are firing a projectile that is ballistically matched with the HE projectile but of a different square weight, we must correct for this difference.

b. The WP, HC, and colored smoke projectiles are ballistically matched to the HE projectile, but often differ in weight. The FDO computes the basic safety data in the same manner as for shell HE with the exception of minimum and maximum quadrant elevations. To determine the quadrant elevations, a correction factor for the difference in weight must be applied to the minimum and maximum ranges. For the minimum range:

(1) First, determine square weight difference.

(a) *Shell WP.* Given:

Shell WP, M110, weight 7 squares (7 $\square$).

Shell HE, M107, standard weight 4 squares (4 $\square$) from TFT.

Difference in square weights:

$$7 \square \text{ (WP)} - 4 \square \text{ (HE)} \\ = +3 \square \text{ (INCREASE of 3 } \square \text{)}$$

(b) *Shell HC.* Generally has the same standard square weight as HE.

If so, use HE safety data.

If there is a square weight difference, use the same procedures as for WP above.

(c) *Colored Smoke.* Given:

Colored smoke weight given in pounds, e.g., shell M116, weight 86.4 pounds.

Shell HE, M107, weight 95.0 pounds (standard).

From the introduction of the applicable TFT, find the weight per square ($\pm 1 \square = 1.1$ pounds).

Difference in square weights: 86.4 (weight shell colored smoke) - 95.0 (weight shell HE) = -8.6 pounds (DECREASE of 8.6).

$$\text{(weight difference)} \frac{8.6}{1.1} = 7.8 \\ \text{(from TFT)}$$

(Decrease of 8 $\square$)

(2) Next, enter table F of the appropriate TFT.

(a) At the nearest listed value to the minimum range, extract the unit correction factor for a projectile weight of 1 square (increase or decrease).

(b) Determine the correction by multiplying the difference in projectile weight (1) by the unit correction (2). Express to the nearest 10 meters.

(c) Apply the correction to the minimum range. Place the hairline of the GFT over the corrected range and read the elevation under the hairline. Add HE site at original range to the elevation to find the minimum QE.

EXAMPLE:

Given:

Shell WP, fuze M564
Min rg 2400 meters
Charge 4 GB

Weight of HE projectile = 4 squares

Weight of WP projectile = 7 squares

Difference in weights of
projectiles = +3 squares

Weight of projectile unit
correction (range 2400 M
from TFT) = +21 meters

Range correction:

$(+21 \times +3 \square = +63 \text{ or } 60) = +60 \text{ meters}$

Corrected range $(2400 + 60) = 2460 \text{ meters}$

Elevation (range 2460)
(GFT) = 130 mils

Site (range 2400) = -4 mils

Min QE = 126 mils

c. Minimum safe fuze setting for M564 will be read under the manufacturer's hairline corresponding to the corrected range; e.g., corrected range 2460 = 8.1 seconds. For fuzes in the M520A1 family, such as M501 MT fuze, the correction factor from the TFT must be applied to the M564 FS determined from the GFT.

d. To determine the maximum QE:

(1) Repeat b(2)(a) above using the maximum range.

(2) Repeat b(2)(b) above.

(3) Apply the correction to the maximum range. Place the hairline of the GFT over the corrected range and read the elevation. Add

HE site at the original range to this elevation to find the maximum QE.

NOTE: IF A REGISTRATION HAS BEEN CONDUCTED, THE ELEVATION AND M564 FUZE SETTING SHOULD BE READ UNDER THE APPROPRIATE GAGE-LINES OF THE GFT SETTING.

★15-10. Safety Data for Shell Illuminating

a. *General.* When the illuminating projectile is to be employed, the FDO computes the basic safety data in the same manner as for shell HE with the exception of minimum and maximum quadrant elevations. Whenever possible the illuminating graphical firing tables (GFT) should be used to compute safety data. This may not always be possible, since range limits may fall off the applicable GFT. In this case safety data must be computed with the tabular firing tables (TFT).

b. *Illuminating safety data computed with the GFT.*

(1) To determine the minimum quadrant elevation using the illuminating GFT—

(a) Place the manufacturer's hairline over the minimum range (time range line as appropriate).

(b) Under the hairline, read the minimum elevation on the "elevation to impact" scale. Add the HE site at that range to the elevation. The result is the illuminating minimum quadrant elevation.

★ (2) The M564 fuze setting corresponding to the elevation determined in (1)(b) above is valid for shell illuminating and can be read from the HE GFT.

(3) To determine the maximum quadrant elevation using the illuminating GFT—

(a) Place the manufacturer's hairline over the maximum range.

(b) Under the hairline, read the maximum elevation on the "elevation to impact" scale. Add the HE site at maximum range to the elevation. The result is the illuminating maximum quadrant elevation.

c. Illuminating safety data computed with the TFT.

(1) To determine the minimum quadrant elevation—

(a) Enter the tabular firing tables (TFT) with the minimum range and determine the corresponding elevation and the change in elevation necessary for a 50-meter change in height of burst.

(b) Compare the battery altitude to the maximum altitude at minimum range and express the vertical interval (VI) to the nearest 50 meters.

(c) Subtract the VI from 750 and divide this quantity by 50 to determine the number of 50-meter increments necessary to move the burst of the round to the ground.

(d) Multiply the number of increments by the change in elevation determined previously and subtract this amount from the elevation corresponding to the minimum range. The result, expressed to the nearest mil, is the minimum QE.

★ (e) Minimum time is the M564 fuze setting corresponding to minimum range.

(2) To determine the maximum quadrant elevation—

(a) Enter the range-to-impact column of the TFT with the maximum range or the next lower listed range. Express the QE corresponding to this range to the nearest mil.

(b) Apply site computed for HE to the result. This is the maximum QE.

(3) The following is an illustration of the procedure for computing minimum and maximum QE and minimum fuze setting for a 155-mm howitzer M109A1, charge 5 white bag, shell illuminating M485A2. The minimum range is 2,500 meters; the vertical interval to the highest point on the minimum

range line is +70 meters. The maximum range is 8,000 meters; the HE site for the minimum altitude at that range is -21 mils.

Quadrant elevation for range

2500 meters (includes
750-meter HOB) = 406.2 mils

Vertical interval (+70
expressed to the nearest
50 meters) = 50 meters

Height-of-burst correction
for down 700 (14 increments
of 50 meters $\times$ 18.7 (elevation
change for 50 meters)) = 261.8 mils

Minimum QE (406.2 - 261.8
= 144.4) = 144 mils

M564 fuze setting corresponding
to range 2500
(minimum time for shell
HE is valid for shell illum) = 7.2

★15-11. Miscellaneous

a. Direct fire. When direct fire is employed, the computation of safety data is the same as that prescribed for low-angle firing. For range, even though firing is conducted by use of the range scale on the direct fire telescope, the safety officer must verify the elevation to insure that rounds fired will be safe. In order to do this, the safety officer must verify safety settings by using the gunner's quadrant or the elevation scale to insure that rounds are not fired below minimum quadrant elevation or above maximum quadrant elevation.

b. Heavy artillery. Because of the great range and resulting drift involved in firing the 175-mm gun, drift for low-angle fire *must* be included in the computation of safety limits prior to registration. Determine the drift for all charges being fired and apply the largest value to all deflection limits.



PART FOUR

TRAINING



CHAPTER 16. DEVELOPING THE BATTERY TRAINING PROGRAM

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Section II. Performance-Oriented Training, Page 16-5

Section III. Developing the Training Program, Page 16-6

CHAPTER 17. BATTERY TRAINING TECHNIQUES

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Section II. Section Training in the Battery, Page 17-2

Section III. Individual Training in the Battery, Page 17-10

Section IV. Battery-Level Training Techniques, Page 17-17

CHAPTER 18. MAINTENANCE PROCEDURES AND TRAINING

CHAPTER 16

DEVELOPING THE BATTERY TRAINING PROGRAM

Section I. INTRODUCTION

THE ARMY TRAINING MISSION
IS TO ATTAIN AND MAINTAIN
THE STATE OF OPERATIONAL
READINESS REQUIRED TO
CONDUCT COMBAT OR OTHER
OPERATIONS IN ACCORDANCE
WITH ASSIGNED MISSIONS.

16-1. General

Preparing and conducting training properly is one of the battery commander's most difficult, but most important, duties. Field artillery batteries are actively engaged in various administrative and support functions that divert their energies from training in their fighting skills. Such requirements as on-duty education, salutes, and range police can severely limit time available for training the battery in its fire support mission. The purpose of this chapter is to present ideas and tools to assist the battery commander in overcoming these training diversions.

16-2. Training Responsibilities

a. Battalion commanders. The battalion commander is the principal training manager. Based on his higher commander's guidance, the Army Training and Evaluation Program (ARTEP), soldier's manuals, and available training resources, he is responsible for developing and implementing a battalion training program designed to prepare his unit—and the soldiers in it—to meet or surpass applicable standards of performance.

b. Battery commanders. The battery commander works with the battalion commander and his staff in developing and implementing the battery training program (see section III for additional information on how to develop training programs). This includes making recommendations concerning battery training needs based on

battery and section training objectives contained in the ARTEP and soldier's manuals. In addition, battery commanders should provide specific instructions to subordinate trainers (NCOs) to assist them in preparing and conducting training using the training objectives in those publications. See FM 21-6 for specific information on how to formulate commander's training guidance.

c. Battery officers and NCOs. These leaders work with their commanders to insure that their sections can successfully perform ARTEP training objectives. This includes assisting the battery commander in identifying training needs and helping his trainers to use the available training resources efficiently and effectively. Each battery officer and NCO should be thoroughly knowledgeable of the soldier's manual tasks and pertinent portions of the ARTEP. Particular emphasis should be placed on understanding the standards of performance that sections must meet. When collective and/or individual training needs are identified, this information must be passed up the chain of command to the BC. The *battery officers* are oriented toward collective training and the unit's operational mission. The *NCO* is the key player in the individual training system. Individual training in units demands decentralizing the responsibility for training their men to the NCOs. *Thus, the NCO is the principal individual trainer.*

16-3. Army Training Philosophy

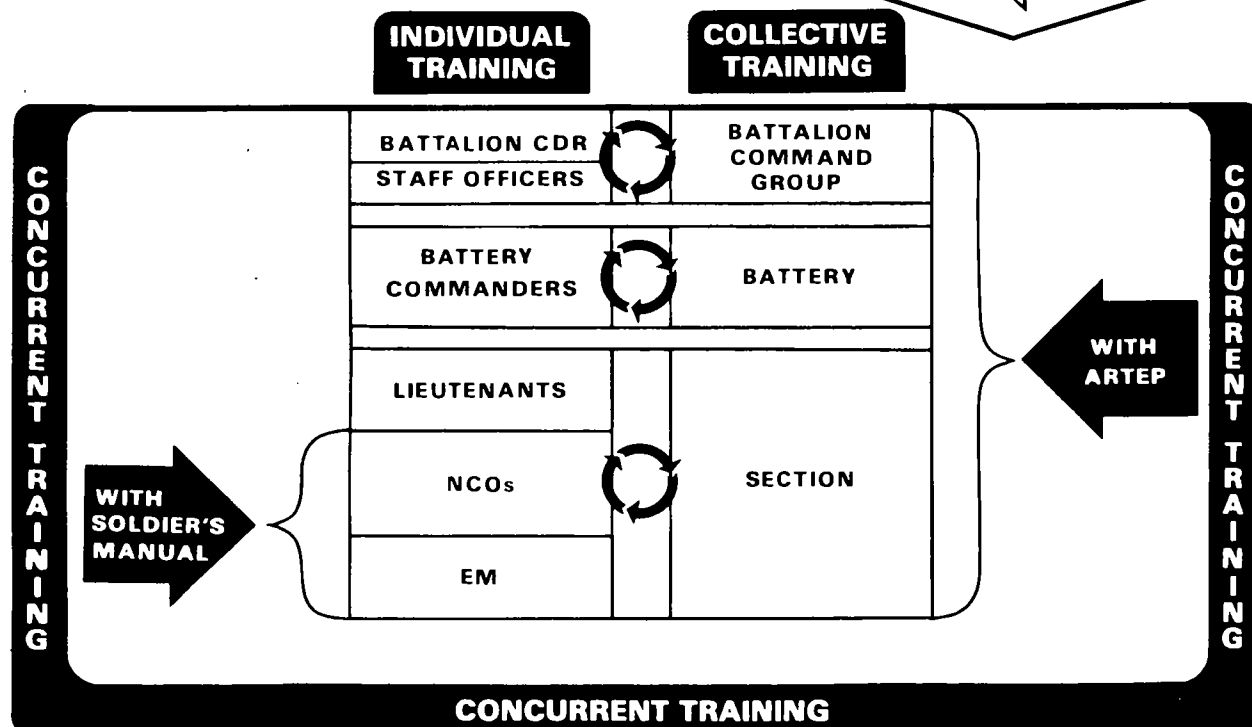
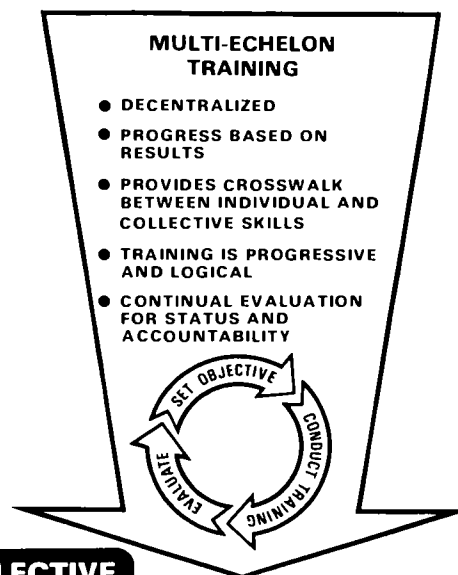
a. It is important that the trainers of the

cannon battery understand the "big picture" of Army training. Under the Army training philosophy, the authority and responsibility to organize, conduct, evaluate, and supervise training is delegated to the battalion or separate battery level. Decentralized training focuses all training effort at or below the battery level, where the job is actually performed. This means the battery commander and his section chiefs *must* be able to determine specific training objectives based on unit mission, the battalion commander's goals and guidance, the available training resources, and the present level of training.

b. The ARTEP serves as a basis for developing field artillery battalion and battery training programs. It provides a listing of critical combat tasks in the form of training and evaluation outlines containing the tasks that cannon battalions, batteries, and sections may be required to perform. These tasks are expressed in the form of collective training objectives that specify the *task* to be performed, the *conditions* under which the task is performed, and the *standard* of acceptable performance. With objectives stated in these terms, commanders

can better determine the specific training needs of their units. (See paragraphs 16-5 and 16-6 for further discussion of performance-oriented training and training objectives.)

c. While the ARTEP is critical to the unit, the soldier's manual (SM) and skill qualification test (SQT) are critical to the individual soldier. A soldier's manual describes what is expected of each soldier at each skill level for that MOS. It contains instructions on how to learn new skills, cites



references, and explains the standards that must be met for evaluation (SQT). *The soldier cannot be promoted unless he qualifies for award of the next higher skill level.* These individual tasks, when taken collectively, form the ARTEP objectives.

d. Any training program must take into account the interaction of individual and collective training as well as the need to conduct both concurrently. This is a part of a multi-echeloned approach to training at several levels simultaneously—section, battery, and battalion.

★16-4. Training Publications

The following is a list of those key training publications that form the basis for any battery training program. These publications must be understood and used by all supervisors involved with training or training management.

a. The *Army Training and Evaluation Program* for the unit.

b. The *soldier's manuals* and *commander's manual* for all unit MOSs.

c. The *operator's manual* and *field manual* for the unit's type of howitzer or gun. (Eventually, the 6-series FMs will be rescinded as their content is merged into "user's manual" TMs.)

d. FM 6-50, *The Field Artillery Cannon Battery*.

e. FM 21-6, *How to Prepare and Conduct Military Training*.

f. TC 21-5-7, *Training Management in Battalions*.

The purpose of these publications will be discussed throughout part four of this manual.

Section II. PERFORMANCE-ORIENTED TRAINING

16-5. General

To understand how the ARTEP should be used in the development of a training program and the preparation and conduct of training, it is necessary to understand the performance-oriented training philosophy. Performance-oriented training focuses on those critical tasks that prepare soldiers for combat. It must guide both training managers as they develop training programs and trainers as they prepare for and conduct training. Unfortunately, this concept of training is frequently only a concept. Many times, commanders and soldiers have witnessed training that has little or no relation to job performance. Such training wastes the limited training resources available and often adversely affects the morale and motivation of the soldiers. Therefore, *the crucial first step is to recognize the purpose of training—preparation for combat.* Once this idea becomes ingrained, both training managers and trainers can proceed with the development of training that serves the needs of the unit and the soldiers being trained.

16-6. Performance-Oriented Training Objectives

a. The key to effective training is the development of performance-oriented training objectives. These objectives facilitate clear and concise thinking about training for combat. This is due to their nature and structure. These objectives must contain a precise statement of the *task* to be performed, *the condition(s)* under which the task is performed, and the *training standard(s)* of acceptable performance.

b. This structure is much different from traditional training objectives, which are vague and hard to measure. For example, it has long been common practice to write a training objective such as the following:

Traditional Training Objective

"To insure that each howitzer section is proficient in the conduct of indirect fire missions."

In contrast, a performance-oriented training objective for the same skill might read as follows:

Performance-Oriented Training Objective

TASK: Each M109A1 howitzer section will conduct indirect fire missions.

CONDITIONS: The battery FDC has announced a fire mission.

STANDARDS:

The howitzer is ready to fire within 30 seconds after receipt of QE for the initial round.

The howitzer is ready to fire within 20 seconds after receipt of QE for subsequent rounds.

The bubbles on the elevation quadrant and panoramic telescope are centered prior to firing.

The correct deflection, QE, fuze, fuze setting, projectile, and propellant are used.

c. The development of these performance-oriented training objectives takes a lot of thought and effort! However, there are some valuable payoffs from this process. These payoffs are described in terms of the training and evaluation equation:

Training Objective = Training + Evaluation

In other words, a precisely written training objective—that actually outlines task, conditions, and standards—is the evaluation for that training.

d. Moreover, the whole training process is governed by the detailed performance objective. With objectives stated in precise terms, one is less likely to waste training time. *The principle of the training and evaluation equation is that we teach and train for the realities of combat.* This is

sometimes a difficult concept for people to understand. Perhaps this issue can best be clarified by reference to nonmilitary activities. Take the case of the football or basketball team preparing for a game. In effect, the coach teaches and trains to win the game. He does this by developing a playbook, which clearly defines tasks (the plays) that he wants his team to perform. He establishes appropriate conditions and standards for his practice (training) sessions. Similarly, the ARTEP can be thought of as the commander's playbook. By specifying in performance terms what the battalion, battery, and sections must be capable of doing, the ARTEP provides the basis for developing training programs and includes much of the information that the trainers need to prepare for and conduct better combat training.

It is important to remember that inherent in the conduct of performance-oriented training is an evaluation. When a howitzer section, for example, is conducting training on a particular ARTEP training objective and they achieve the published standard, they have in effect been evaluated. Personally monitoring ongoing training and receiving reports from subordinates will help keep the commander aware of current training status without dedicating his limited resources to an evaluation or a test. Also, the commander should be aware that training proficiency is very perishable. Evaluation and revision of the unit training program must be a continuous affair.

Section III. DEVELOPING THE TRAINING PROGRAM

16-7. General

a. TC 21-5-7, *Training Management in Battalions*, has been written specifically for training managers. It describes a four-step process (fig 16-1) that explains how to develop training programs and amplifies the training philosophy upon which the process is based. This publication should be used in

conjunction with the ARTEP and soldier's manuals to develop the battery training program.

b. The four-step process is a logical process to follow in selecting training goals, planning for the conduct of training to achieve these goals, and insuring that the training is properly supported. Also, it shows when to

evaluate the results of training and permits adjustment of the program to better achieve

training goals. In a diagram, the process of training management looks like this:

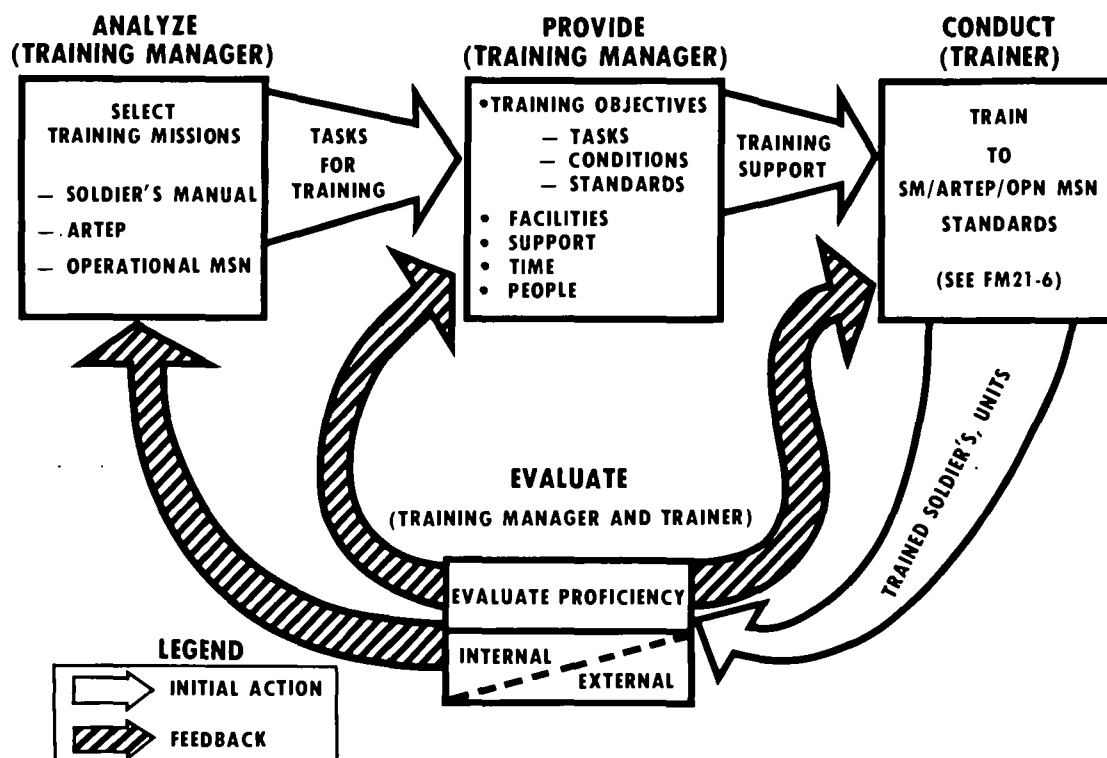


Figure 16-1. The four-step training process.

c. This scheme involves only the application of common sense and can be followed without difficulty by anybody in a unit. It must be understood that the training process is never finished. As the diagram indicates, training management is a *continuous* process. At battery level, it depends on "cut and fit" methods, on trial and error in matching what the commander wants to do with what the unit has the time and other resources to accomplish. Every time a unit receives a new mission, or has a significant change in its personnel, or conducts an evaluation that reveals a need for additional training, its training program will have to be adjusted. The objective is to *build and sustain readiness in the unit to perform its assigned missions—readiness of individuals, readiness of sections, and readiness of the battery as a unit.*

16-8. Training Program Analysis

During this phase you must determine where your unit should be in terms of training, where it really is now, and what training is needed to get from "really is" to "should be."

★ a. Determining where your unit should go in training.

(1) An extremely useful tool to assist the battery commander in establishing individual and unit performance objectives that, if attained, will insure his battery's ability to satisfactorily perform its assigned mission is the training crosswalk (fig 16-2). There are over 100 collective training tasks affecting the firing battery in ARTEP 6-365 and about 280 individual training tasks in the skill level 1/2 13B soldier's manual. The number of training combinations from just these two manuals is enormous and can be

★ complex and confusing to trainers and training managers unless they know how to use the manuals. Main points are:

(a) Understand how to crosswalk between the ARTEPs and soldier's manuals to determine *what* and *who* must be trained.

(b) Select groups of individual and collective tasks to correct a training deficiency.

(c) Do not become bogged down in trying to train to all standards at the same time.

(2) The ARTEP is the cornerstone, because the collective tasks the battery *must* perform relate directly to its ability to fight effectively. This is how the training crosswalk works. ARTEP 6-365, *155 SP Direct Support Cannon Units*, and the soldier's manuals for MOS 13B and 13E are used as examples. It is assumed that the battery cannot transfer outside transfer limits effectively.

(3) The trainer begins by referring to ARTEP 6-365, chapter 3, section II, and reading the task entitled, "Conduct an FFE mission on a target outside transfer limits (fuze time)." This is a task that requires participation by many different people and sections in the battery.

(4) To refine further what training tasks are required, he next refers to chapter 3, section I, in the ARTEP to determine what tasks the sections must perform to support the battery task.

(5) At this point, *all* collective tasks required to accomplish the battery task have been identified. The final step is to review the soldier's manual for each MOS in each section that must participate in accomplishing the battery task.

(6) Using this process, related tasks at each echelon from the soldier to the battery are identified. The ultimate benefit from this process is that *deliberate, coherent, effective, and realistic* training to correct a training deficiency can take place at every echelon *simultaneously*.

b. Determining where your unit is now in training.

(1) The next step in the analysis phase is for the battery commander to determine the current level of individual and unit proficiency in the training objectives previously identified. Ideally, the battery commander would conduct a realistic live-fire field training exercise (FTX) at battery level, based on the ARTEP, to make this determination. In most batteries, however, the training resources to conduct battery-level FTXs ("dry" or "wet") are not available. In such cases, subjective evaluations of the current battery proficiency might be made by examining past performance results and consulting with battery officers and NCOs as to the training proficiency of their sections. If a more objective field evaluation *can* be done—do it!

(2) Many good commanders lack confidence in the information received from subjective evaluations. Even though it might be impossible for them to conduct a battery-level diagnostic field evaluation, it is certainly within the capability of an imaginative battery commander to conduct *section-level* diagnostic field evaluations. Since the ARTEP lists critical section tasks, which, when taken collectively, equal battery-level ARTEP tasks, evaluating/training sections on the basis of the ARTEP section training objectives would be the *next best thing* to evaluating the entire battery. These section-level diagnostic evaluations can serve as the basis for the unit training program in garrison during those periods when resources preclude the battery going to the field.

(3) Let's briefly look at how the battery commander and his subordinate leaders can do this with limited training resources. The following methods can be employed in conducting evaluations of the cannon battery elements:

(a) Since the cannon section evaluation (app C) is based on the howitzer section training/evaluation outlines in the ARTEP, it does not require live ammunition and can be administered in a restricted local training area. It permits the battery commander to determine the strengths and weaknesses of an entire section (see chapter

★ 17 for a more detailed discussion of training and evaluating cannon sections).

(b) An evaluation using the M31 field artillery trainer has limited value for evaluating cannon crews. It can be extremely effective in the evaluation of FO and FDC sections.

(c) A fire direction center evaluation should be based on the ARTEP. A complete evaluation of the FDC can be accomplished easily by adapting the firing battery headquarters training/evaluation outlines into a tactical scenario. All that is needed (in addition to the FDC's TOE equipment) is an area large enough for the FDC and "canned" missions/situations fed into FDC over wire or radio by an evaluator.

(4) In some cases, the battery's state of training and resources might make it difficult to conduct pretraining diagnostic evaluations even at the section level. The battery commander and battery leaders should then conduct pretraining evaluations at the *individual* level. These evaluations should be based on the tasks listed in the *soldier's manual*. The individual training objectives listed in the soldier's manuals are critical combat tasks, which, when taken collectively, equal section-level ARTEP tasks. So, evaluating/training individuals on the basis of SM training objectives would be the next best thing to evaluating each section on the basis of the ARTEP training objectives. The soldier's manual could be used as the source for creating a series of performance-oriented test stations. The number and organization of the test stations would depend on the MOS of the soldiers

Conduct an FFE mission on a target outside transfer limits (fuze time).

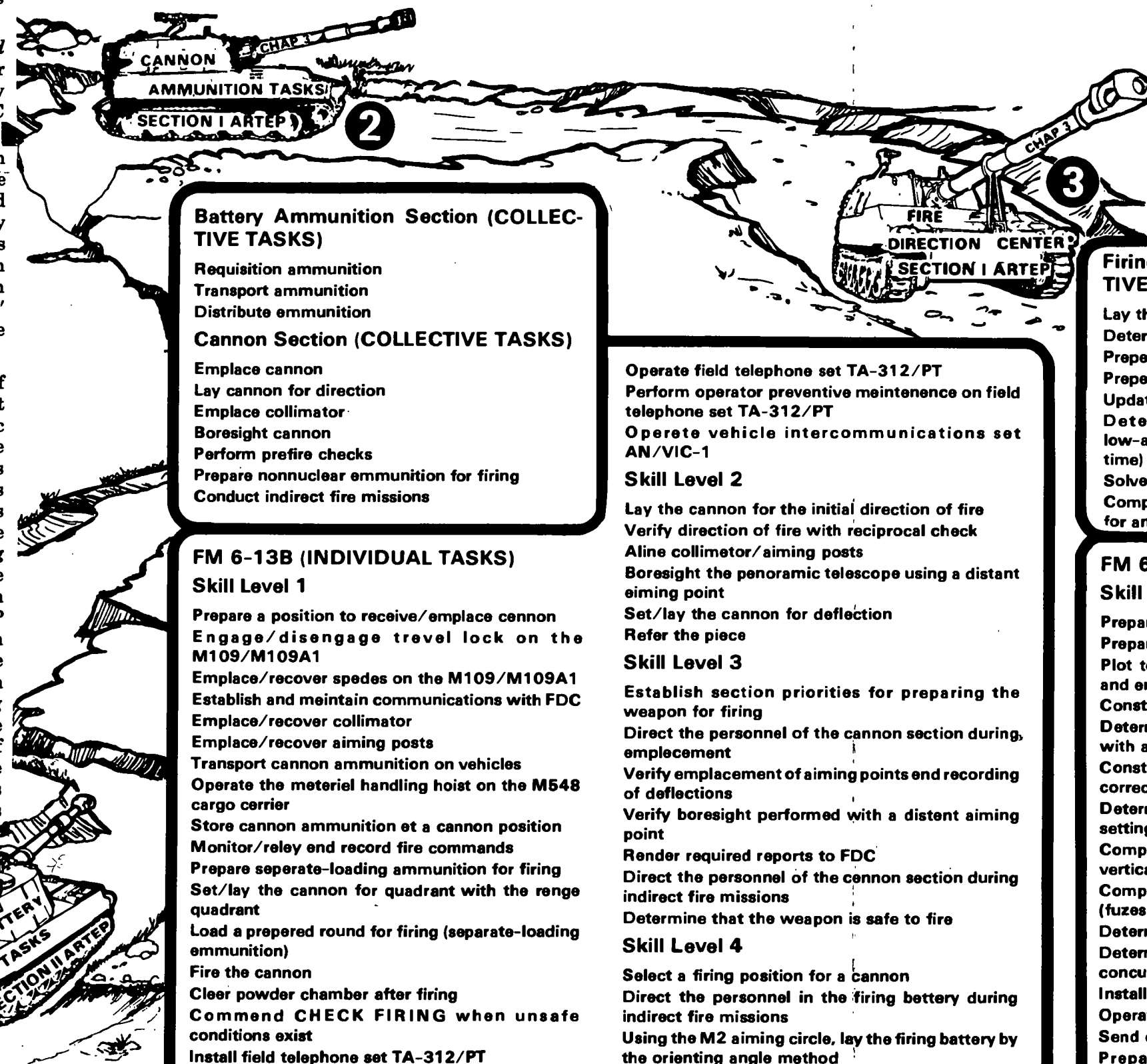


Figure 16-2. Training crosswalk.

being evaluated and the imagination of the evaluator. The test might be organized along the line of the gunner's qualification test (app D).

(5) Also, the commander should use the SQT results as a training management tool in determining specific areas of individual training weakness. The SQT is a performance test that allows the individual soldier to demonstrate proficiency in a sampling of tasks extracted from his soldier's manual. The test is given every year but must be taken and passed by the individual only once every 2 years. A task that cannot be performed by several tested individuals probably indicates a battery-level training weakness!

WARNING: There is always a temptation for training managers to use the traditional sequential training approach; i.e., evaluate/train individuals, then sections, then batteries, then the battalion. A **HOSTILE TRAINING ENVIRONMENT WILL NOT TOLERATE THIS APPROACH!** There is not enough time in a typical unit's schedule to support an annual sequential training cycle. The commander must determine the **HIGHEST** level at which meaningful multiecheloned and decentralized training can be conducted. Evaluation begins at that level.

c. Determining Training Needs.

(1) *Individual and unit training needs are determined on the basis of:*

**WHERE YOUR UNIT
SHOULD GO IN TRAINING
MINUS
WHERE YOUR UNIT IS NOW
EQUALS
TRAINING NEEDED**

For example, ARTEP 6-365 establishes the level of proficiency for emplacing the M109A1 howitzer as 30 seconds after stopping in position. While conducting phase

IV of the cannon section evaluation, the battery commander might discover that five of his six howitzer sections cannot meet this standard. This indicates that training is needed in emplacing the howitzer.

(2) When the commander finishes evaluating his sections (or individuals) on all applicable training objectives identified in the ARTEP (or SM), he will have identified strengths and weaknesses in his unit that will help him formulate a training program.

IMPORTANT: When it has been determined that units cannot perform successfully in one or more of the ARTEP training objectives, it is necessary to determine the *exact reason* for failure. During the pretraining evaluation, the evaluator should attempt to identify training deficiencies at a level *one echelon below* the level at which he is evaluating. For example, if the commander is conducting an evaluation of the *battery's* ability to conduct an adjust fire mission, any training shortcoming should be identified with a specific *section* (howitzers, FDC, or FIST).

16-9. Providing Resources for Training

a. After identifying his training needs, the battery commander must determine what resources are available to support these training requirements. These resources are:

(1) *Human* resources—the soldiers available for training and those available as trainers.

(2) *Physical* resources—the equipment, buildings, and training areas available for use in training.

(3) *Financial* resources—those funds allocated for conduct of training activities and purchase of training aids/devices or other material used in training.

(4) *Time*—perhaps the most limited of all training resources.

b. By analyzing the battalion training

calendars, the battery commander will quickly realize that most of his time and resources have already been allocated for him. Limited training resources, however, should never be the scapegoat for ineffective training. Innovative, imaginative, and proper management of resources can result in effective training. Here are some tips to help the battery commander get the most out of his limited resources:

(1) *Use the 14.5-mm M31 field artillery trainer and the artillery direct fire trainer (ADFT) for individual and section training.* The M31 and ADFT are effective tools for developing competence in indirect fire and direct fire procedures, respectively. Both training devices can be used in limited local training areas to build teamwork and proficiency prior to live-fire exercises. For information concerning firing battery procedures, firing range construction, training, and maintenance, refer to TM 9-6920-361-13&P (M31) and TM 6-6920-357-10-2 (AFDT).

(2) *Use the resources of your local Training and Audiovisual Support Center (TASC).* In addition to the motion pictures and related audiovisual aids indexed in DA Pamphlet 108-1, your local TASC can obtain training devices listed in DA Pamphlet 310-12. These devices include terrain boards, weapon mockups, enlarged firing charts, and realistic training ammunition.

(3) *Make use of the Field Artillery School and other schools.* The US Army Field Artillery School (USAFAS) provides the battery commander with a number of means of preparing and conducting professional training programs and classes. Among the resources available are:

(a) Class packets for conducting formal platform instruction.

(b) Programed texts adaptable for performance-oriented training.

(c) Video tapes useful for conducting formal instruction.

(d) Correspondence courses for individual or group study.

(4) *Use the training extension course*

(TEC) program. The TEC lessons are geared to soldier's manual tasks and are designed so that the individual soldier can use one of three approaches—audiovisual, audio only, or printed material. TEC is targeted at the individual soldier or small groups. Each lesson is performance oriented and allows the soldier to take an active part in the presentation. With TEC, a unit learning center can be set up and tailored to the individual soldier's need for self-paced training in basic MOS-related skills.

(5) *Enforce a firm policy of prime time for training.* Many commanders have succeeded in marking off established periods of time devoted exclusively to training. This can be done on a daily, weekly, monthly, or quarterly basis (e.g., 4 hours each day, 2 days each week, or 1 month each quarter). Administrative absences can be limited to times other than prime training time. Utilization of block leave policies helps enforce prime time training by making better use of available training time.

(6) *Establish policies within the battery to maximize training time.* Assign entire sections instead of individuals from various sections to necessary duties. This promotes better use of training time and enhances section training. Each section chief must know exactly where every section member is all the time. He should conscientiously attempt to use all available bits of training time. When he has only a portion of his section for duty, it might be appropriate for them to clean protective masks, crew-served weapons, or section equipment or to work on individual TEC lessons. Trips to the post exchange, quartermaster sales, and barbershop should be consolidated and planned so that they do not interfere with meaningful training or maintenance periods.

Only after carefully identifying the resources available can the commander determine which performance objectives he can accomplish. Expecting a unit to do too much with too few resources is a common failing.

16-10. The Conduct Phase

a. Determining training to be conducted. During this phase, the commander must determine the training to be conducted, program the training, and then conduct the training.

(1) Ideally, the battery commander would select for training all of the performance objectives he previously determined during the analysis phase. This probably will not be possible, so he should consider available resources and focus on the objectives that make the greatest contribution to accomplishment of the unit mission. He can do this by using the following three-phase process:

(a) Establish training priorities. The performance objectives for which training is needed should be ranked in the order of their contribution to mission readiness. This listing must reflect guidance on priorities established by higher headquarters as well as judgment of the battery commander. The following might assist in establishing priorities:

★ The battery commander should insure that his unit can accomplish the training objectives appropriate to the training level (1 or 2) directed by the commander.

★ Level 1 provides for the minimum degree of training proficiency for a fully combat-ready unit. Level 2 provides for the degree of training proficiency required of a unit with severe training restraints such as time or the lack of equipment. The primary criteria for level 2 present a realistic goal for Reserve Components.

(b) Estimate training resources. The time, personnel, equipment, and training areas required to meet each of these performance objectives should be realistically estimated.

(c) Allocate available training resources. The resources available to support training should be allocated in accordance with the established priorities.

(2) There are three obvious benefits to be derived from this three-phase process.

(a) First, by having done his "homework," the battery commander can justify his needs for additional resources and can address the mission impact if his requests are denied.

(b) Second, the process will surface any misunderstandings as to the relative priorities for the unit's various tactical and administrative missions. If the emphasis is incorrect, it should become apparent in the response from higher headquarters to requests for training support.

(c) Third, it provides higher headquarters a rational basis for allocating its training resources to subordinate units.

(3) This process is crucial to development of a training program. It can mean the difference between satisfaction and frustration when the commander is dealing with a higher headquarters on matters related to training priorities and support.

b. Programing training.

(1) In the previous steps, the battery commander determines and schedules the performance objectives selected for training. He programs these performance objectives on the basis of:

(a) When the required resources (firing ranges, local training areas, ammunition, etc.) will become available.

(b) A logical sequence of conducting training from easier to more difficult tasks.

(2) Failure to schedule and program carefully *well in advance* can cause problems for both the trainer and the soldiers. The principal documents used by the cannon battery to program and schedule training are the training forecast and the weekly training schedule. The training forecast is any type of calendar device used to indicate the performance objective to be taught each day, the time to be devoted to each, and any training directed by higher headquarters. It is the primary reference in the preparation of the weekly training schedule and normally covers a quarterly period. Long-range planning depicted in the training forecast is general in nature. However, within 1 month of the conduct of training, the forecast should

become fairly specific (performance objective, time, and references should be included).

(3) An important part of scheduling training is the selection and notification of the trainers. Trainers should be alerted *as far in advance as possible* to give them maximum time for adequate preparation. To assist them, the battery commander/training officer should provide them with complete training guidance as described in FM 21-6.

c. Conducting training.

(1) The quality of the steps already completed in this system will be revealed clearly during the conduct of training. The common focus of all previous steps is the battery, section, or individual training objective selected for training. The task, condition, and standard of the PERFORMANCE OBJECTIVE defines the conduct of training. Training should consist of problems and exercises that are designed to insure that the soldier, section, or battery can accomplish the training objective.

(2) FM 21-6, *How to Prepare and Conduct Military Training*, was developed for trainers. It guides the trainer through a step-by-step process for preparing and conducting training. Using FM 21-6 as a general guide and using the tips presented in chapter 17 of this manual, trainers should be able to conduct meaningful performance-oriented training.

(3) Remember that *performance evaluation* is a vital part of the conduct of each training session. It provides the battery commander with continuous feedback on learning achieved. This feedback, in turn, provides valuable information and data for revising the current training program.

16-11. Evaluating Training

a. Evaluating training is simply an up-to-date report of where your unit is now in

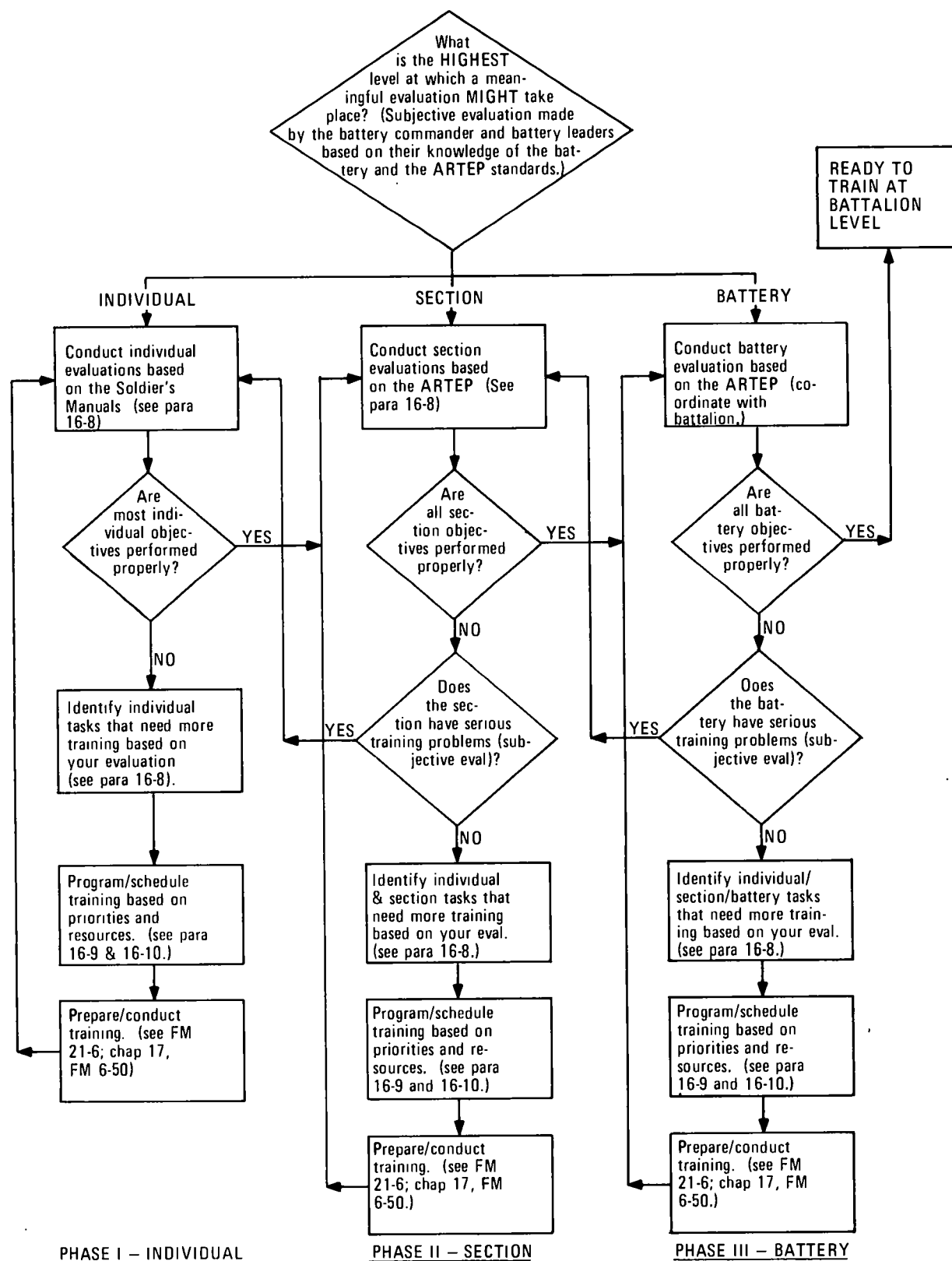
training. Specifically, the commander is making another determination of whether the various individual, section, or battery training objectives can be met.

b. One basis for this determination should be the performance evaluation conducted during each training session. The battery commander is then insuring that he has reached the training level he had set out to reach. If he has not successfully attained his goals, he begins the training cycle again with the new input from his evaluation. If he has accomplished his goals, he renews the cycle at the next higher level of training. Again, much of this is accomplished subjectively as an inherent part of performance-oriented training.

★16-12. Summary

a. Figure 16-3 is a summary of training at the battery level. It shows the relationship between individual-, section-, and battery-level training and the training literature that should be used in conjunction with each step.

b. A warning, however, is in order. Figure 16-3 is a simplified model that attempts to explain a very complex problem—training in the hostile training environment. There are few, if any, batteries that have all individuals and sections at the same level of training. For example, a cannon battery commander might find that three of his howitzer sections need to undergo individual training/evaluations (phase I), the other three howitzer sections and the FDC are conducting section training/evaluations (phase II), and the battery commander is conducting a certain amount of battery-level training (phase III). This multiechelon approach to training recognizes that a strict training cycle in which all sections are at the same training level at the same time is a rarity. However, a battery commander should be able to fit each of his *sections* into one of the phases depicted in the figure.



★ Figure 16-3. Battery-level training cycle model.



CHAPTER 17

BATTERY TRAINING TECHNIQUES

Section I. INTRODUCTION

17-1. General

a. The previous chapter presented brief explanations of the Army training system, the performance-oriented approach to training, and the training management process. It was written primarily for the battery commander, who—with the battalion commander—must plan, organize, conduct, evaluate, and supervise the training of his battery, using the ARTEP and soldier's manuals as his guides.

b. This chapter will present various techniques that might be used by the battery commander and *his trainers* (battery officers/NCOs) to prepare and conduct training in the most effective and efficient manner. The discussion in this chapter is geared primarily toward the training of the battery's sections, excluding the fire direction center. The training of these personnel is ★ covered in FM 6-40.

17-2. The Trainer's Role

a. FM 21-6, *How to Prepare and Conduct Military Training*, was developed for trainers. It was designed to be used with TC 21-5-7, *Training Management in Battalions*, the soldier's manuals, and the ARTEP. FM 21-6 describes a three-step backward planning process that trainers should use to prepare and conduct training. These steps are:

Step 1: Describe the Desired Results of Training

Step 2: Prepare to Conduct Training

Step 3: Conduct Training to Standards

b. In step 1, the trainer obtains the battery commander's training guidance, describing precisely what the soldier must be able to do at the completion of training (the commander's training objective is based on the ARTEP/SM). This guidance should also

tell the trainer to whom the training will be given, when and where the training will take place, and why the commander decided that training was needed. If the commander's guidance is incomplete, the trainer must develop this information himself, using FM 21-6, the SMs, and the ARTEP.

c. In step 2, the trainer develops, if necessary, those intermediate training objectives that will make the training logical and progressive. This is important when the commander's training objective is complex in nature (e.g., the indirect fire mission objective discussed in paragraph 16-6). Next, the trainer organizes training by determining the order in which intermediate objectives are taught and by estimating the required resources.

d. In step 3, the trainer actually conducts the training to insure the soldiers meet the training standards established in the commander's objective. In conducting performance-oriented training, the trainer must make every effort to hold lectures and conferences to a minimum. The majority of training time must be devoted to hands-on training. This performance-oriented approach lends itself to a training session (a class or a block of instruction) consisting of three phases:

PHASE I: The trainer states the purpose of the training and explains or demonstrates how the task will be performed. This part should be as brief as possible.

PHASE II: The soldiers practice the task under close supervision to acquire the degree of proficiency required by the training standard.

PHASE III. The soldiers are tested by performing the task to the established training standard. Those who meet the standards can proceed to another activity; those who do not should be critiqued on

mistakes, should continue practicing, and should be reevaluated.

e. FM 21-6 discusses the three-step backward planning process in detail, with examples showing how it applies to individual and collective training. This chapter will not repeat the detail of FM 21-6 but will present additional training techniques for the battery to supplement the training process presented in FM 21-6.

NOTE

The remainder of this chapter is divided into the following sections:

Section II addresses how to train *sections* in the battery with emphasis on howitzer section training.

Section III addresses the training of *individuals* who normally do not participate in collective section training and training in common individual skills.

Section IV presents some *battery-level* training techniques for molding the various battery sections into a battery team.

Section II. SECTION TRAINING IN THE BATTERY

17-3. General

a. The objectives of section training are to—

- (1) Train individuals in their principal duties,
- (2) Train the section as a team, and
- (3) Cross-train individuals in the various duties within the section.

b. The section chiefs are the principal trainers in the battery during the conduct of section training. By insuring that each section chief is qualified to do his job, the battery commander takes a big first step in developing effective section training (see paragraph 17-10).

c. Even though AR 350-1 does not require any formal record of individual or section training in the firing battery, some system should be established to record the training progress of each soldier and each section in the battery. However, care should be taken to prevent the administrative portion of

training from becoming a burden.

(1) Each section chief could use a notebook in which he keeps an informal daily record of training conducted, individuals present for instruction, performance objectives accomplished, deficient areas noted, and any other remarks concerning the training of his section. These records should be examined regularly by the XO, CFB, and GSG to help them evaluate training and program future activities.

(2) The soldier's manual and job book are excellent tools for noncommissioned officers or other first-line supervisors in maintaining a record of each soldier's progressive achievements in individual training. The job book is a pocket-sized pamphlet. It lists the critical tasks from the soldier's manual for each man's duty position and has columns for the entry of the results of the soldier's most recent evaluation on each task. The *pencil* entry is made on a "GO" or "NO GO" basis with the date and the initials of the trainer.

17-4. Training Cannon Sections— A Situation

a. Training cannon sections would be a relatively simple chore if the ammunition, time, and ranges were available to permit frequent, full-scale, live-fire exercises. However, cannon batteries in today's training environment have little, if any, of these valuable resources. Let's join an M109A1 firing battery in Germany where a BC is discussing the battery's training challenge with his officers and NCOs—

...I just got out of a staff call with the battalion commander and the S3. The battalion will undergo a training evaluation in three months near the end of our month of intensive training at Graf (major training area). While we're there, battalion is going to give the battery two weeks to train by itself in preparation for beginning battalion-level training. The "old man" has decided that an evaluation of each battery will be done at the end of the first two weeks to see where we stand. That means that we now have two

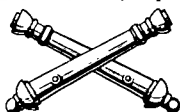
months to prepare ourselves for battery-level training, and two and one-half months to prepare ourselves for battalion-level training. I've received the battalion training calendar for the next two months. We have only three days per week for the next two months in which to conduct training. Of course, no ammo is available, and we can only use our local training area and 14.5 range. I've been reading FM 6-50 and I have some ideas for developing battery-level teamwork before going to Graf (see section IV). 1SG and GSG—you'll both be working with me on this. XO, CFB, and FDO—I want you to organize training within your respective sections so that we can start training as a complete battery the day we arrive at Graf...

b. Place yourself in the position of the battery XO, CFB, or GSG. Where do you go from here?

17-5. Training Cannon Sections— A Solution

a. While figure 16-2 shows the relationship

TC6-13B1/2(JB)



CANNON CREWMAN

JOB BOOK MOS 13B10/20

**REFERENCE:
SOLDIER'S MANUAL FM6-13B1/2**

NOT TO BE INSPECTED

**NAME
UNIT
JOB**

TASK NO.	TASKS	GO	NO GO	DATE
001-13B				

M110/M107

-1129 (2-20)	Operate the Oilpump Winch			
-1028 (2-26)	Bore-sight the Direct Fire Telescope Using a Distant Sighting Point			
-1035 (2-28)	Bore-sight the Direct Fire Telescope Using the Targeting Target			
-1138 (2-41)	Prepare Separate Loading Ammunition for Firing			
-1024 (2-48)	Sight on a Target with a Direct Fire/Elbow Telescope			
-1017 (2-48)	Load a Prepared Round for Firing (Separate Loading Ammunition)			
-1124 (2-51)	Ram a Projectile with the Loader-Rammer			
-1126 (2-53)	Measure the Depth of Ram			
-1151 (7-12)	Operate an M110/M107 Under Unusual Conditions			

between the various levels of training, it also can help the XO/CFB/GSG with their present training challenge. Figure 16-2 suggests a systematic approach toward solving the training mission given to the XO/CFB/GSG by the BC; that is, to prepare the cannon sections to enter phase III of the training cycle (battery-level training) within the time allotted (2 months).

b. By examining figure 16-2, these leaders see that they must first determine the present training status of their cannon sections. This is necessary in order to identify those tasks which require more training. This determination could be made subjectively; however, an objective evaluation could easily be accomplished by using the evaluations in the appendixes of FM 6-50, the SMs or the ARTEP. Subjectively, the XO/CFB/GSG determine whether to begin their training cycle with individual (phase I) or section (phase II) evaluations.

c. The XO/CFB/GSG should begin their evaluation at the *highest* level at which meaningful results might be obtained. (There always will be a temptation to employ the sequential building-block approach to training. However, there just is not enough time to use this approach.) For other than newly organized units, this initial evaluation should probably occur at section level (phase II).

d. Assume the XO/CFB/GSG feel that cannon section evaluations might provide meaningful results. Their next step would be to administer the cannon section evaluation to all of their cannon crews, following the instructions given in appendix C. This can be done in a local training area with little space and no ammunition. It can be administered to one section at a time by the XO/CFB/GSG or to all sections at one time using six evaluators (perhaps the BC, XO, FDO, 1SG, CFB, and GSG).

e. The next step is critical. The XO/CFB/GSG must carefully analyze the cannon section evaluation results to determine those tasks which require additional training. For example, the first task of phase IV is the portion of the cannon section evaluation that tests the cannon

section on its ability to perform indirect fire missions. Evaluation of this task will determine if the sections can perform indirect fire missions properly and, if not, the exact reason(s) for failure. For example, the XO/CFB/GSG might evaluate this task and conclude—

The 5th cannon section cannot conduct indirect fire missions properly because:

The gunner cannot align his pantel on the aiming point correctly.

The assistant gunner cannot level the elevation quadrant properly.

By examining the results achieved by all six cannon sections, the XO/CFB/GSG will have identified those individual and collective tasks needing more training.

f. The actual preparation and conduct of training should be accomplished by the section chief. The section chief should be provided with a copy of the section evaluation results and should be given as much flexibility as possible to correct all deficiencies indicated by the evaluation. He should understand that this is "his show" and that the heat is on him to get his section prepared. Every effort should be made to give him time to train his section and to have all personnel available to him during training sessions.

(1) In conducting his section training, the section chief should base each training session on one or more collective tasks that were performed improperly during the section evaluation. The section chief will first want to employ the three-phase approach (see paragraph 17-2d) to train his section in those *individual* skills that were lacking during the section evaluation. By referring to the 13B soldier's manual, the section chief will know the exact performance objectives for his individual training sessions and the references he needs to use (TMs, FM's, TCs, TEC, etc.) to help him conduct his training. After training his section on those individual skills lacking during the section evaluation, the section chief should conduct section practice of the collective task to insure his

section can now perform its team effort properly.

(2) Let's look at our example of the 5th cannon section shown above. The section chief of this section knows that he must train—

(a) His gunner to align the pantel on the aiming point,

(b) His assistant gunner to level the elevation quadrant, and

(c) His section to perform indirect fire missions.

The section chief will want to correct his individual deficiencies before practicing the section task. By referring to the soldier's manual, he notes that the gunner's shortcoming is covered by task #061-13B-1039 in the 13B soldier's manual (FM 6-13B1/2, 3, 4). He finds this task listed in chapter 2 of FM 6-13B1/2. Each task in the soldier's manual lists a performance objective (task, conditions, and standards) and the training steps needed to teach the task. Also listed is the exact reference to help supplement the information given in the soldier's manual. In this case, there are also five TEC programs listed (TEC lessons 041-061-6103-F through 041-061-6107-F) that can effectively teach the gunner the skill if the section chief feels TEC will be more efficient or effective than personalized instruction. In other words, the soldier's manual gives the section chief everything he needs to prepare and conduct this individual instruction. The same is true of the assistant gunner's training deficiency.

(3) The above situation is a good example of why maximum flexibility must be given to the section chief. *Not all sections have the same training problems!* Why teach all gunners to align the pantel on the aiming point if only one gunner is deficient in that area? The individual section chief is also in the best position to use his other personnel who are not actively involved in training. He might want the other cannoneers to participate with the gunner and/or the assistant gunner in order to promote cross-training. He might have them performing maintenance during this time. He might have

to utilize these individuals to meet certain detail commitments. *The point is, the section chief is in the best position to conduct training and to employ all section personnel in an efficient and effective manner.*

(4) At the completion of individual training sessions, the section chief should then practice the collective task with the entire section. This will insure that the section can perform their collective team effort properly.

g. The XO/CFB/GSG have a definite role during the preparation and conduct of this section training. They should review the cannon section evaluation results with each section chief and jointly map out a plan on how to correct any shortcomings. This plan should include a decision on how best to use all available time to correct the errors found during the section evaluation. If the XO, CFB, GSG, and section chief have a clear understanding of the training needed, there should be little problem with giving the section chief enough time and resources to solve his training problems. On the basis of this "game plan," the XO/CFB/GSG should observe training sessions to insure that the section chief is using his time and people effectively. The XO/CFB/GSG might want to conduct their own intermediate evaluations on selected tasks to check training progress. These intermediate evaluations can help pace the training and keep it moving ahead.

h. After giving the section chief sufficient time to remedy his training shortcomings, the XO/CFB/GSG should repeat the administration of the cannon section evaluation, if necessary, to all their cannon crews. This provides immediate feedback to the XO/CFB/GSG as to whether remedial training was conducted properly. If all tasks are now performed properly, the cannon sections are probably ready to begin training at battery level. If all tasks are not performed properly, only the tasks not properly performed should be repeated. This time, however, the XO/CFB/GSG should try to carefully analyze *why* the deficiency recurred. Was ineffective training conducted? Did personnel change in key positions? Were

needed training resources unavailable? Hopefully, the XO/CFB/GSG can identify the underlying problem and correct it.

In summary, the cannon section evaluation is not just a test. It is a tool available to the BC, XO, CFB, GSG, and section chief for training their cannon sections. Even though it was established to support training in a garrison-type environment without live-firing ranges or ammunition, it is *based on existing ARTEPs* and will assist the BC, XO, CFB, and GSG in preparing their cannon sections for battery- and battalion-level training and evaluation also based on the ARTEP.

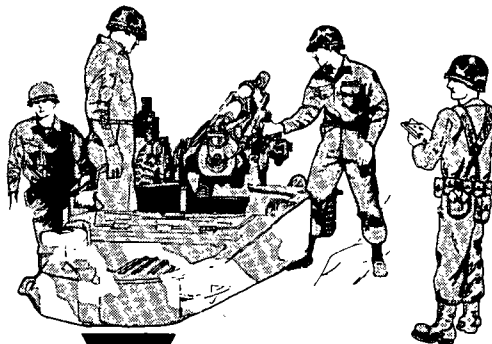
17-6. Training Cannon Sections in Newly Activated Units

a. The solution to section training problems presented in paragraph 17-5 was based on a situation in which the firing battery was relatively well trained and had enough organization so that meaningful results could be obtained from a cannon section evaluation. Suppose, however, that

your situation is not that good. What if you are presented with the problem of training a newly activated unit with new personnel and new equipment? Or perhaps you are the XO, CFB, or GSG of an "established" firing

IN TRAINING ESTABLISHED CANNON SECTIONS....

- **START BY ADMINISTERING THE CANNON SECTION EVALUATION.**

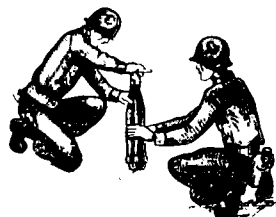


- **THEN ANALYZE THE RESULTS....**

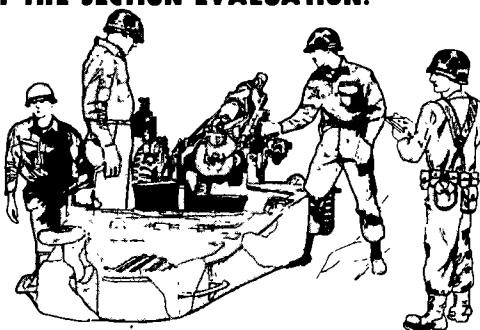


...TO IDENTIFY TASKS (INDIVIDUAL AND COLLECTIVE) REQUIRING FURTHER TRAINING.

- **GIVE THE SECTION CHIEF THE RESULTS, AND THE RESOURCES TO PLAN AND CONDUCT THE REQUIRED TRAINING. XO/CFB/GSG HELP PLAN, THEN OBSERVE.**



- **REPEAT THE SECTION EVALUATION.**



- **ONCE ALL TASKS ARE PROPERLY PERFORMED, PROCEED TO BATTERY-LEVEL TRAINING.**

battery that has recently undergone a drastic personnel turnover, which prohibits a meaningful evaluation at section level. How can you conduct meaningful training to mold your personnel into functioning teams?

b. In these cases, you will probably have to employ a technique more closely related to the traditional sequential approach to training. Examine figure 16-2 again. Your firing battery probably should begin training in phase I (individual training). However, *no unit can afford to assume that section members know nothing and reteach all basic skills*. The trainer must identify those skills in which his personnel are proficient and those in which more training is required. The commander's manual for MOS 13B (FM 6-13B/CM) will identify those tasks that were taught to 13B personnel during every step of their military education (OSUT, PNCOC, BNCOC, and ANCOC). However, assuming that your personnel are masters of every task indicated in the commander's manual is just as bad! A more objective evaluation of your individual 13B personnel can be accomplished by using the soldier's manual.

c. How training is conducted to correct the individual training deficiencies depends on the number of qualified trainers the XO/CFB/GSG have at their disposal. Every attempt should be made to allow the section chief to train his own section personnel by following the guidelines established in paragraph 17-5. However, in many cases the section chiefs might need as much training as their section personnel. In these cases, the XO/CFB/GSG will probably need to employ a more centralized approach to training by combining personnel of approximately the same proficiency under the trainers available. For example, the CFB might need to personally conduct training for unqualified section chiefs; the GSG might need to train gunners; and available proficient section chiefs might need to conduct cannoneer training. If this approach is used, the XO/CFB/GSG should make every possible attempt to qualify the section chiefs as soon as possible, and return the training requirement back to section chief control (where it belongs).

17-7. Cross-Training Within Cannon Sections

a. The techniques presented in paragraphs 17-5 and 17-6 can be employed to fulfill the first two objectives of section training; i.e., to train individuals in their principal duties and to train the section as a team. However, the third, and last priority of section training is to cross-train individuals in the various duties within the section. While cross-training will probably always be the last priority of section training, it is extremely important to the overall mission readiness of a firing battery and to the professional development of the individuals in the section. Units will not be able to operate effectively if soldiers can perform only one job properly. Individual soldiers will not be able to qualify for promotion unless they become proficient in all tasks associated with their present and *next higher* skill levels in the SQT. Let's look at some techniques that might be used in a cross-training program.

b. A unit can conduct a centralized cross-training program by using the soldier's manual and section evaluations contained in FM 6-50 and the techniques presented in paragraphs 17-5 and 17-6. After progressing through the section training phase (see figure 16-2), the firing battery should be prepared to conduct battery-level training. In most cases, however, the time and resources needed to conduct battery-level training will not be available at the same time the sections are prepared to conduct this training. This is the ideal time to emphasize section cross-training. The XO/CFB/GSG might then reenter the section training phase (phase II, fig 16-2) with each person occupying either a job one position higher than his normal job or someone else's job at the same level. For example, the gunner acts as the section chief, the assistant gunner becomes the gunner, a cannoneer becomes the assistant gunner, and so on. The section is given the section evaluation while in this configuration. Training is prepared and conducted by the section chief on the basis of the results of the section evaluation (see paragraph 17-5).

c. Another cross-training technique that might be used is to evaluate the section with

IN TRAINING NEWLY - ORGANIZED CANNON SECTIONS...

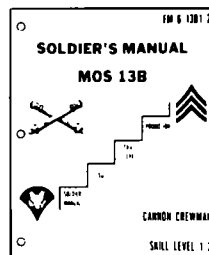
- **START AT THE INDIVIDUAL LEVEL. IDENTIFY REQUIRED TASKS AND DEFICIENCIES THROUGH**

1 COMMANDER'S MANUAL (FM 6-13B/CM)



AND

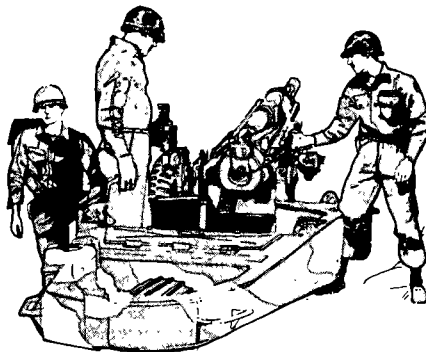
2 THE SOLDIER'S MANUAL (FM 6-13B1/2)



- **CORRECT INDIVIDUAL DEFICIENCIES THROUGH**
 - **INDIVIDUAL EFFORT (TEC, FM'S, ETC.)**
 - **DECENTRALIZED TRAINING (SECTION CHIEFS)**
 - **CENTRALIZED TRAINING (XO/CFB/GSG)**



- **ONCE INDIVIDUAL PROFICIENCY IS ESTABLISHED, GO ON TO SECTION - LEVEL TRAINING.**



- **CONDUCT CANNON SECTION EVALUATION. ANALYZE RESULTS TO DETERMINE DEFICIENCIES, THEN PROCEED AS FOR AN ESTABLISHED SECTION.**

each person at a skill level one step above his present duty position. For example, each 13B10 is evaluated on the tasks identified in the soldier's manual for the gunner and each 13B20 is evaluated on the tasks shown for the section chief. Since these evaluations are progressive in nature, the evaluation results identify those tasks needing training at the skill level tested and at lower skill levels. The XO/CFB/GSG are then identifying new skills needed to be taught and old skills that still need refreshing. The section chief prepares and conducts training on the basis of the results of these individual evaluations (see paragraph 17-6).

d. Some form of section drill is another tried method available to the XO, CFB, GSG, and section chief to promote cross-training within a section. Section drill, as shown in the appropriate 6-series weapon field manual, can be useful as a training tool to familiarize all section members with the various section duties, especially during emplacement and march order of the weapon. However, the XO/CFB/GSG should realize that section drill can quickly become monotonous and boring and does not drill all individual skills requiring cross-training.

e. In the long run, the individual soldier also must become personally involved in his own cross-training and skill progression. Never before has the individual soldier had so much quality training literature and so many training devices to assist in his own training. *The primary tool the individual soldier has is his own copy of the soldier's manual.* It is designed to help the soldier train himself. In this manual is a training and evaluation outline for each task the individual is required to master. Each training and evaluation outline states what he must be able to do (task), the equipment he needs to perform the task (conditions), how well he must be able to do the task (standards), the best method for performing the task (training steps), and references to help teach the task in detail. The soldier can use this manual in conjunction with TEC lessons and correspondence courses to build his own proficiency in his present and next higher skill levels. The commander can be of assistance in this effort by insuring that each

individual has the proper manual and knows precisely what it contains and how to use it. See section IV for additional details on conducting and monitoring decentralized individual training.

17-8. Training an Ammunition Section

a. The primary mission of the battery ammunition section is the transport and delivery of ammunition. The training of this section should focus on the tasks related to this mission: driving, ammunition handling and storage, maintenance of ammunition and ammunition vehicles, map reading, RTO procedures, etc. The ammunition section chief initially should be concerned with training all his section personnel to become proficient wheeled vehicle drivers. Since driving is such a major portion of the ammunition section mission, the battery commander should be very hesitant to assign an individual to the ammunition section who is incapable of, or unmotivated toward, becoming a qualified driver. Paragraph 18-4 offers guidance on operator training and supervision and should be referred to by the XO, CFB, and ammunition section chief in setting up this very important first part of the ammunition section training program.

b. The XO/CFB/GSG must bear in mind that the ammunition section members must maintain proficiency in their 13B duties. This could be done by assigning each ammunition section member to a parent cannon section for garrison training. The ammunition personnel should train side-by-side with the cannon personnel when not engaged with more critical ammunition section training. During field training, each member could perform the duties of a cannoneer in his parent cannon section after performing his ammunition section duties. The battery ammunition sergeant could sometimes serve as acting chief of section during the absence of any regular cannon chief of section.

c. Since a battery ammunition section normally has only a few personnel, the use of TEC lessons and correspondence courses in conjunction with the soldier's manual is a very effective teaching vehicle for training the ammunition section.

17-9. Preparing Soldiers for the 13B Skill Qualification Test (SQT)

The skill qualification test (SQT) is a performance-oriented individual evaluation (replacing the MOS test) the individual soldier is required to take to validate his proficiency at his present skill level. The introduction to the 13B soldier's manual gives the soldier an excellent description of the composition of the SQT and how to prepare for it. The following important point should be made to the BC, XO, CFB, GSG, and section chiefs concerning SQT preparation:

The soldier's manual is the basis for the SQT. All the training techniques recommended in the previous four paragraphs are based upon the soldier's manual. By following these techniques (or your own unique techniques based on the soldier's manual) you will eliminate the need for a period of frantic preparation prior to the SQT. In addition, the soldier's perception will be that his battery's training program is geared to help him meet the requirements of the Enlisted Personnel Management System—and *he will conclude that his training is meaningful.*

17-10. Preparing Cannon Section Chiefs to be Firing Battery Trainers

a. The section chief is the primary trainer in the cannon battery. The battery commander must be assured that a cannon section chief has the appropriate technical

expertise. The skill level 3 tasks in the soldier's manual can be used to help identify any weaknesses of the sections chiefs. The XO/CFB/GSG can then set up a training program to teach the needed skills.

b. Once minimum proficiency is attained, a system must be established to insure that all section chiefs maintain proficiency in their duties and prepare themselves for the next higher grade. One of the best methods to increase the MOS proficiency of a section chief and to help him advance in his career is to prepare an individual training program based on correspondence courses and/or the 13B soldier's manual. Paragraphs 17-12 and 17-13 describe how to conduct and monitor such programs.

c. Besides maintaining the appropriate job skills needed to be a firing battery trainer, *the cannon section chief must be able to prepare and conduct training properly.* While many section chiefs have received some formal training in methods of military instruction, many of them have not received training in how to prepare and conduct performance-oriented training in accordance with the concepts and procedures emphasized in FM 21-6 and the tasks identified in chapter 8 of FM 6-13B3. To remedy this, appendix F of FM 21-6 contains complete guidance on the training of trainers, to include lesson plans and a list of training aids needed. By using appendix E of FM 21-6 and chapter 8 of FM 6-13B3, commanders can insure that their NCOs have the fundamental skills necessary to handle performance-oriented training sessions.

Section III. INDIVIDUAL TRAINING IN THE BATTERY

17-11. General

★Section II of this chapter presented some techniques for training MOS 13B personnel (refer to FM 6-40 for the training of MOS 13E personnel). In the battery, these personnel normally train and function as a group under the supervision of their chief of section, GSG, CFB, AXO, or XO. The mission of the individuals in the battery

headquarters and communications section is mostly day-to-day support of the entire battery. Normally, these personnel do not participate in collective training except for battery-level field exercises and mandatory personal knowledge classes. Therefore, it is most practicable to set up an individual OJT (on-the-job training) program for these individuals who must actively support the battery during most garrison training and

who are not part of the normal battery collective training program. Various units set up on-the-job training programs in different ways. This section presents two different OJT techniques that might be used by the battery commander and a brief discussion of training in personal knowledge subjects.

17-12. Conducting Individual OJT Programs by Using the Soldier's Manual

a. The individual OJT programs should be based upon this invaluable training manual. A program using the soldier's manual as its basis can have all of the advantages of a program based solely on correspondence courses while combating the inflexibility and incompleteness of such a system.

b. As previously explained (see paragraph 17-7), the soldier's manual is designed to help the soldier train himself. In addition to listing all critical performance objectives (in an explicit task/condition/standard format), the soldier's manual lists the training steps/performance measures the soldier must master to perform the objective properly. All appropriate training media (i.e., DA publications and TEC) are listed for each performance objective, giving the individual and his supervisor flexibility in selecting the most appropriate training medium for learning the task. By knowing the individual's military schooling history, his daily job requirements, and his total MOS skill requirements, the battery commander, first-line supervisor, and the individual can mold an individual training program that is beneficial to both the battery and the soldier.

c. The commander's manual (CM)

published for each MOS can be an excellent management tool for the battery commander and section chief in preparing and conducting an individual OJT program. Table 17-1 is an extract of one of the task lists appearing in the commander's manual for MOS 13B. The task list contains the critical tasks for the MOS arranged in skill level order. Within each skill level, the tasks are organized into the functional categories used in the soldier's manual. Each task statement is followed by a list of training references and the skill level of initial training. This is followed by columns used to indicate where this training should take place. The letter "I" in a column indicates the location of initial training for a task, and the "R" indicates the location of refresher training.

17-13. Conducting Individual OJT Programs by Using Correspondence Courses

a. An effective method of establishing and maintaining MOS proficiency for the various personnel in the battery headquarters (and for supervisory personnel) is by utilizing the correspondence/OJT courses offered by the various service schools. These courses can be used to qualify personnel with no prior experience or formal training in the MOS and to maintain the proficiency of school-trained personnel. Table 17-2 is a list of typical cannon battery headquarters MOSs for which individual OJT programs may be necessary and the correspondence/OJT course available for that program. Table 17-3 gives similar information for cannon battery supervisory positions.

b. The battery commander should

AN INDIVIDUAL OJT PROGRAM REQUIRES

- PROGRAMMED STUDY PERIODS
- AVAILABILITY OF NECESSARY EQUIPMENT
- APPROPRIATE SUPERVISORY ASSISTANCE



Table 17-1. Extract from FM 6-13B/CM

TASK NUMBER	TITLE	TRAINING MATERIAL REFERENCE	SKILL LEVEL INIT TNG	RESPONSIBILITY/LOCATION FOR INITIAL TRAINING					
				INSTITUTIONAL			UNIT		
				OSUT	PNCOC	BNCOC	ANCOC	SOJT	SELF
-0542 (9-61)	Perform Equipment Serviceability Criteria (ESC) Evaluation on a 2½ Ton Cargo Truck	TM 9-2320-209-ESC TM 9-2320-209-10, Chap 3 TM 38-750, Chap 3 LO 9-2320-209-12 TEC Lesson 510-091-6458-F TEC Lesson 510-091-6486-F	1			R		I	R
-0544 (9-63)	Perform the Before/ During/After Operations Checks and Services on the 5-Ton Cargo Truck	TM 9-2320-211-10, Chap 3 TM 9-2320-260-10, Chap 3 LO 9-2320-211-12 LO 9-2320-260-12	1			R		I	R
-0545 (9-64)	Operate a 5-Ton Cargo Truck Under Usual Conditions	TM 9-2320-211-10, Chap 2 TM 9-2320-260-10, Chap 2 LO 9-2320-211-12 LO 9-2320-260-10	1					I	
-0547 (9-66)	Operate a 5-Ton Cargo Truck Under Unusual Conditions	TM 9-2320-211-10, Chap 2 TM 9-2320-260-10, Chap 2 LO 9-2320-211-12 LO 9-2320-260-12	1					I	
-0548 (9-68)	Perform Equipment Serviceability Criteria (ESC) Evaluation on a 5-Ton Cargo Truck	TM 9-2320-211-ESC TM 9-2320-211-10, Chap 3 TM 9-2320-260-ESC TM 9-2320-260-10, Chap 3 TM 38-750, Chap 3 LO 9-2320-260-12 LO 9-2320-211-12 TEC Lesson 510-091-6458-F TEC Lesson 510-091-6486-F	1			R		I	R

consider the following advantages in establishing this type of program:

(1) This program is soldier oriented. The individual can move at his own pace. The supervisor assists in and monitors the instruction rather than controls it.

(2) The individual is forced to become proficient in all tasks required of his MOS rather than just those he is presently performing in his day-to-day work. This program increases *all* aspects of MOS proficiency and results in improved duty performance and SQT results.

(3) Additionally, AR 600-200 (chapter 7) provides that 0.5 promotion point will be allocated for every 1 lesson credit hour completed (up to a maximum of 125 points). Thus, the individual and the unit benefit from this individual training program.

c. A battery commander who uses correspondence courses as the basis for an OJT program may feel that his responsibility for training these individuals has passed to the service school that publishes the individual correspondence course. This is definitely *not* the case. AR 350-1 states: "When it (self-study) is mission related, unit commander should encourage and provide maximum assistance, including obtaining study materials and providing time and facilities, to assist subordinates in self-study." The following are some ways that the commander might enhance an individual OJT program utilizing correspondence courses:

(1) Obtain several copies of the correspondence course catalogs of service schools that offer courses applicable to his firing battery MOSs. He can obtain these by writing to the addresses listed in tables 17-2 and 17-3.

(2) Keep a progress record of all individuals in the battery enrolled in a correspondence/OJT program. Also, the first sergeant should keep a progress record of all NCOs enrolled in a correspondence course, and each section chief should do the same with his section members. By maintaining these records, the battery leaders show their interest in individual progress and have a basis for counseling and encouraging

individual soldier. Table 17-4 is an example of a format that can be used by the battery commander, training officer, or section chief. It can be changed to suit the tastes of the individual battery commander. One chart can be used for all personnel in correspondence courses. The dates entered indicate when each subcourse was completed. Keeping these data current will be no problem, since the service schools send the battery commander a computer-printed notification after completion of each subcourse and a certificate of completion (or a diploma) at the end of an entire course.

(3) Establish a room where personnel can study after duty hours in the proper atmosphere. For those batteries that do not have these facilities, an MOS study room containing an MOS library and TEC facilities might be feasible at battalion for use by all personnel.

(4) Treat completion of a correspondence course in the same manner as graduation from a service school. The certificate of completion or diploma should be awarded in an appropriate award ceremony, and the approval of a pass might also be warranted. In a word—recognition!

(5) A battery commander can best assist an individual in an correspondence program by providing time during duty hours for him to work on his courses. A firing battery might also schedule 4 hours per week as a "professional period" during prime training time. This time should be devoted exclusively to individual MOS proficiency. During these times of MOS study, the following groups might work together in individual or group study:

(a) Cannon section chiefs, gunners, the chief computer, and ammunition sergeant working on individual correspondence courses under the supervision of the CFB and GSG.

(b) All 13Bs, grades E4 and below, working under the supervision of the XO, AXO, CFB, or GSG. The soldier's manual can be used as a basis for performance-oriented training drills in preparation for the annual skill qualification test. Training extension

courses can also be used effectively to refresh the individual soldier's knowledge and to polish basic MOS skills.

(c) All 13Es, grades E5 and below, working under the supervision of the XO, AXO, or chief computer. The soldier's manual and TEC can also be used as a basis for this program.

(d) Battery headquarters and communications personnel working on correspondence courses under the supervision of their section chiefs. While the use of correspondence courses does offer many advantages as an approach to training, there are also some definite shortcomings that the battery commander should realize.

Because the administration of the correspondence course program is centralized and highly computerized, there is a certain amount of inherent *inflexibility* in the system. For example, some courses dictate the exact order in which individual subcourses may be taken, the reserve stocks of some subcourses can become depleted, and enrollment takes a couple of weeks.

Even though the authors of correspondence courses attempt to write at the level of their prospective students, there is a heavy reliance on the *reading ability* of the individual soldier. Soldiers with severe reading difficulties might not be able to overcome this hardship.

Additionally, most correspondence courses do not cover all material that a soldier needs in preparation for his skill qualification test. Complete reliance on correspondence courses for MOS training and refreshing might be injurious to the individual soldier.

17-14. Personal Knowledge Training

a. There is a certain amount of individual knowledge that all soldiers *must* have regardless of rank or MOS. Personal knowledge subjects are specified by AR 350-1 and include the following:

- (1) Military Justice (AR 350-212).
- (2) Code of Conduct (AR 350-30).

(3) Survival, Evasion, and Escape (AR 350-225).

(4) The Geneva/Hague Conventions (AR 350-216).

(5) Service benefits (allowances, reemployment, and honorable discharge).

(6) Policies in key areas (e.g., human relations and drug/alcohol abuse).

b. The regulations covering these subjects are fairly explicit. However, the battery commander should realize the following points in scheduling instruction in personal knowledge subjects:

(1) The regulation covering military justice training (AR 350-212) is the only regulation covering mandatory personal knowledge that specifies an exact course of instruction. Commanders must take this into account when programing training and, normally, should program military justice training for those personnel required to attend once every 6 months.

(2) The other regulations covering mandatory personal knowledge subjects (i.e., AR 350-30, AR 350-216, and AR 350-225) do not specify length or frequency of instruction. They simply state those areas in which the individual soldier must have a working knowledge. A policy of scheduling these subjects on the training schedule every 3 to 6 months could waste valuable training time if most of the battery already understands these subjects. Some alternatives are:

(a) Diagnostic testing of battery personnel every 3 to 6 months on these mandatory subjects and remedial classes for those who are deficient.

(b) Integration of these mandatory subjects into a battery commander's periodic 1-hour seminar.

(c) Permanently posting on the battery bulletin board copies of lesson plans or fact sheets on these personal knowledge subjects, and then utilizing these as a basis for individual questioning during in-ranks

inspections, guard mounts, soldier-of-the-month boards, and promotion boards. This

gets the entire chain of command involved with these subjects constantly.

Table 17-2. Correspondence Courses for Battery Headquarters Personnel

DUTY POSITION	COURSE TITLE	ADDRESS—APPLICATION OR CATALOG
Mechanic	Wheeled Vehicle Mechanic Correspondence/OJT Course. Tracked Vehicle Mechanic Correspondence /OJT Course.	Army Correspondence Course Program (191) US Army Training Support Center Newport News, VA 23628
Equipment maint clerk	Equipment Maintenance Clerk Correspondence/OJT Course	
	Unit and Organizational Maintenance, Repair Parts Supply, and Storage Correspondence Course, Course 159.	(101) See Note 3.
Power generator operator	Power Generator Operator MOS 52B20	(051) See Note 3.
Armorer (supply asst)	Unit and Organizational Supply Basic Correspondence Course. Unit and Organization Maintenance, Repair Parts Supply and Storage Correspondence Course.	(101) See Note 3.
	Small Arms Maintenance Correspondence Course I. Maintenance Correspondence Course II.	
Cook	Dining Facility Operations Correspondence Course. Food Service Administration and Field Operations Correspondence Course.	

Notes.

1. Refer to DA Pamphlet 351-20, *Army Correspondence Course Program*, for detailed guidance on enrollment, grading, etc.
2. Battery headquarters personnel in grade E4 who are MOS qualified should also consider enrollment in the NCO basic courses listed in table 17-3.
3. Administration of all correspondence courses has been centralized at the Army Training Support Center. The only variation in the address for the course application or catalog is the program number (in parentheses).

Table 17-3. Correspondence Courses for Battery Supervisory Personnel

DUTY POSITION	COURSE TITLE AND GRADE REQUIREMENTS	ADDRESS—APPLICATION OR CATALOG
First sergeant	Special Correspondence Course for Company Administrative Personnel (any grade).	Army Correspondence Course Program (121) US Army Training Support Center Newport News, VA 23628
Chief of firing battery or gunnery sergeant	Field Artillery Cannon NCO Advanced (E6 or E7). Cannon Firing Battery (any grade).	(061) See Note 3.
Howitzer chief of section or ammo sergeant	Cannon Firing Battery (any grade). Field Artillery Cannon NCO Basic (E4 or E5). Field Artillery Cannon NCO Advanced (E6 or E7).	(113) See Note 3.
Commo chief	Field Artillery Communications (any grade).	
	Tactical Electronic Equipment Maintenance NCO Basic (E4 or E5, MOS 31G or 31D). Tactical Electronic Equipment Maintenance NCO Advanced (E6 or E7, MOS 31G or 31D).	
Chief FD computer	Cannon Fire Direction (any grade). Forward Observation (any grade). Field Artillery Cannon NCO Basic (E4 or E5). Field Artillery Cannon NCO Advanced (E6 or E7).	(061) See Note 3.
Motor sergeant	Mechanical Maintenance NCO Basic, E40 (E4 or E5). Mechanical Maintenance NCO Advanced, E42 (E6 or E7).	(191) See Note 3.
CBR NCO	Unit CBR NCO Correspondence Course (E5 or above).	

Table 17-3. Correspondence Courses for Battery Supervisory Personnel—continued

DUTY POSITION	COURSE TITLE AND GRADE REQUIREMENTS	ADDRESS—APPLICATION OR CATALOG
Supply sergeant	Supply NCO Basic Correspondence Course (E4 or E5). Phase I, USAQMS NCO Advanced Correspondence Course (E6 or E7).	(101) See Note 3.
Food service sergeant or first cook	Food Service NCO Basic Correspondence Course. Phase I, USAQMS NCO Advanced Correspondence Course (E6 or E7).	

Section IV. BATTERY-LEVEL TRAINING TECHNIQUES

17-15. General

All too often a battery commander takes his entire battery to the field for a live firing exercise as soon as he feels each individual section is proficient in its duties. Then he discovers that his radio equipment doesn't work properly, that the advance party is disorganized, that priorities for occupation have not been established, that the first sergeant does not know how to organize for defense, or any of a number of other problems. Then nearly a hundred soldiers stand around watching "quick-fix" corrections being made. The battery commander must keep in mind that *a field training exercise (FTX) is not the sole method of developing battery teamwork*. When men, training areas, ammunition, and time are limited, the battery commander must select the tactical exercise that best accomplishes the immediate training objective with the least expenditure of resources. Throughout this manual, training tips are given for teaching certain field artillery skills and procedures. This section presents an overview of a suggested building-block technique for molding the various battery sections into a cannon battery team.

17-16. Tactical Exercises Without Troops

The terrain exercise, or tactical exercise without troops (TEWT), is a tried method of

training. During this exercise, the disposition and/or movement of simulated troops or equipment is planned and discussed at a particular location. A TEWT involves nothing more than a leader taking his subordinates to a predetermined tactical location and discussing application of various tactical principles. Some examples of the application of this technique are:

a. A TEWT involving the battery commander accompanied by his XO, AXO, 1SG, CFB, GSG, and the communications chief would be the first step in a battery tactical exercise. The battery commander would go with these subordinates to different tentative firing positions. An informal, two-way, question-and-answer discussion of such things as positioning of howitzers, organization of the position area, installation of communications, entrance routes, placement of the aiming circle, location of outposts and listening posts, and employment of crew-served weapons would surface problem areas and resolve them before going any further in training. The battery commander does not have to make meticulous preparations for the TEWT, but he must have a firm idea of the tactical principles of reconnaissance, selection, and occupation of a position.

b. A TEWT can be an educational experience for all persons involved, and it permits the battery commander to spend a

Table 17-4. Correspondence/OJT Program Progress Record

[illegible]

great deal more time with the battery leaders than would be possible if the entire unit were present.

17-17. Command Post Exercise

a. The second step in this recommended training sequence is a command post exercise (CPX). A CPX is a tactical exercise for the command, communications, and fire direction personnel of a unit. The purpose of a CPX is to permit leaders at all levels to go through the command and control procedures involved in a firing battery operation in the same manner as they would in an FTX or in combat. It is recommended that the following personnel take part in a firing battery CPX.

- (1) The BC and 1SG with vehicle.
- (2) The XO or CFB/GSG with vehicle.
- (3) A fire support team (FIST) with all TOE equipment (provided by battalion).
- (4) The entire FDC and BOC with all TOE equipment.
- (5) The entire communications section with all TOE equipment.

b. The battery commander should develop a scenario that calls for the initiation of fire missions, displacement, and reports similar to those listed in the appropriate ARTEP. The value of a CPX is that it can be accomplished in about one-third of the time it would take for a full-scale exercise. The CPX will help surface procedural errors, communications problems, and unfamiliarity with the battery field SOP. A fast-moving scenario is the key to a good CPX. Actions should be initiated according to how the situations are presented and how the different sections react. The battery commander may interrupt at times to offer a critique. The duration of the exercise depends on its value in the eyes of the battery commander. At the conclusion of the CPX, all participants should gather to discuss the exercise.

17-18. Advance Party Rehearsals and Emplacement Drills

a. Rehearsal for the advance party is the next logical step in our sequence. The training and organization of the advance

party is discussed in chapter 3. The battery commander should make the rehearsal as realistic as possible—as though it were the real thing. Rehearsals should include preparation of cannon positions, selection of alternate and supplementary positions, determination of the track plan, emplacement of route markers, and guiding of simulated cannons into position. These rehearsals can be the key to a smooth occupation during all subsequent tactical exercises.

b. While the battery commander is conducting rehearsals for the advance party, the XO and CFB might profit by conducting emplacement drills for the remainder of the battery. Such drills can help save valuable time and prevent damage to equipment during future field exercises. Also these drills provide a means of insuring that all components of stored equipment are present and serviceable. These drills might include emplacement of such things as:

- (1) Tents,
- (2) Camouflage nets,
- (3) Cannon section installations,
- (4) The RC-292 antenna,
- (5) Generator sets,
- (6) A portable latrine, and
- (7) Immersion heaters.

c. These drills can be interesting training exercises, especially when competition is built in by the battery leaders.

17-19. The M31 Field Artillery Trainer

The M31 (14.5-mm) trainer can be used effectively in the initial phases of the combined training of cannon crews, fire direction personnel, and FIST observers. Together with specially designed FADAC tapes and graphical equipment, the M31 system allows realistic fire direction center computations, good ground observation practice, and total system integration at nominal cost. By using the M31 at this point in the training sequence, the battery can make a preliminary evaluation of the performance of the firing battery team (FIST-

FDC-cannon) and correct faults without utilizing expensive service ammunition. (See TM 9-6920-361-13&P on the employment of the M31.

17-20. Command Post Exercise with Base Piece

a. The final preparatory step in our sequence leading up to a firing battery FTX is a CPX with base piece. The CPX with base piece is a live firing exercise involving only one cannon section. The following personnel participate in addition to those discussed in paragraph 17-17:

- (1) Base piece section.
- (2) One gun guide from each nonparticipating cannon section.
- (3) Support personnel (maintenance, ammunition, supply, mess) as designated by the battery commander.

b. A complete real-time scenario for this base piece CPX can be established directly from the ARTEP. The unit can then undergo a mini-FTX of all missions established in the ARTEP while using only about 50 percent of the ammunition required for a full-scale firing battery ARTEP. Most of the same problems that would have occurred in a full FTX will surface.

17-21. Field Training Exercise (FTX)

A full-scale firing battery FTX should be the highlight of any battery-level training sequence.

a. A well-conducted field exercise offers the battery commander two well-defined products. First, it demonstrates the ability of the entire unit to perform under simulated combat conditions and identifies training requirements for future training. Second, it offers a test of those skills and techniques taught during previous exercises.

b. Successful conduct of a field exercise depends upon a complete scenario based on the ARTEP and good control by battery leaders or higher headquarters.

c. The FTX should be conducted under

complete tactical conditions so that the commander will not waste his time and that of his men. The commander should allow the battery headquarters to take full part in the tactical play. All TOE equipment should be taken to the field. This exercise is one of the best vehicles the commander has at his disposal for practicing the many aspects of the unit field SOP.

d. It is nearly impossible to keep all members of the battery gainfully employed during the conduct of an FTX; therefore, the battery commander must give consideration to concurrent training before going out on an FTX. The commander should give priority to those subjects that cannot be thoroughly learned in a garrison-type environment, such as setting fuzes, storage of ammunition, recovery of vehicles, construction of field fortifications, and cross-country driving.

e. The battery commander must also give careful consideration to the post-FTX recovery period. Plans for this should be made *before* the FTX.

Battery-level training can use the following successive steps in approaching complete mission readiness:

Tactical exercise without troops (TEWT).

Command post exercise (CPX).

Advance party rehearsals and emplacement drills.

M31 (14.5-mm) trainer exercise.

Command post exercise with base piece.

Field training exercise (FTX).

17-22. Summary

The success of the field artillery cannon battery on the battlefield will depend heavily on the maintenance of its weapon systems and the superiority of its tactics and techniques. Of even more importance will be the *proficiency of individual soldiers, sections, and batteries*. The weapons and tactics of the cannon battery will be effective

in combat only to the extent that we train our soldiers to exploit their full capabilities. The individual soldier must be convinced—totally convinced—that we can win. Therefore,

above all else, the battery commander must find ways to train in today's hostile training environment that will improve the effectiveness of his battery in combat.



CHAPTER 18

MAINTENANCE PROCEDURES AND TRAINING

18-1. General

a. *Preventive maintenance (PM)* is the heart and soul of the entire maintenance system. The commander should bear in mind that maintenance repairs and services cost dollars—his OMA funds. Excessive maintenance results in high operating and funding costs. Inadequate maintenance leads to premature breakdowns and failures, which result in excessive downtime and, in turn, high operating costs.

b. The basic Army mission dictates a requirement for every soldier to perform proper preventive maintenance on his equipment. On the battlefield units likely will be operating alone or unsupported for undetermined periods of time and under a wide variety of terrain and weather conditions. Obviously, there is much interdependence of men and equipment that must be coordinated to sustain a combat capability under varying degrees of isolation. The time consumed in awaiting the arrival of a maintenance support team or in evacuating an unserviceable item for repairs may mean the difference between mission success and failure.

c. The primary objectives of maintenance, in accordance with the principles set forth in AR 750-1, are to achieve maximum conservation by preventive maintenance of equipment, to reduce replacement requirements through the conversion of unserviceable materiel to a serviceable status, and to insure maximum use of supplies and equipment in the hands of using personnel. Thus, the commander must relate to his own maintenance program the seven factors that influence maintenance. These factors are:

FACTORS AFFECTING MAINTENANCE

Repair parts

Tools and test equipment

Time

Facilities

Personnel

Publications

Command

18-2. Responsibilities and Functions

It is true that preventive maintenance is the job of every individual. There are, however, different types and degrees of responsibilities and functions. The effectiveness of the PM program depends upon a realistic appraisal of the duties and responsibilities of the various members of the battery.

a. *Role of the commander.* For the most part, the commander in the PM program is concerned with four areas—policy, standards, inspections, and enforcement.

(1) *Policy.* As with other activities, success is often dependent on the troops' understanding of what is wanted and who is responsible for getting it done. The commander's policy can best be disseminated through a maintenance standing operating procedure (SOP). The SOP should outline or specify maintenance procedures, fix responsibility, and indicate where coordination is necessary. A good SOP is complete but concise. A lengthy and overly detailed SOP may well be ignored.

★ (2) *Standards.* The commander must set the maintenance standards. He must insure that the maintenance effort is oriented toward combat readiness instead of "eyewash." Too often, a commander will leave a motor pool of clean, neatly aligned vehicles or a maintenance shop camouflaged with clean tools, records, and supply manuals without knowing that 20 percent of his equipment will not operate!

(3) *Inspection.* Inspection is the key to an effective PM program. The commander must conduct *frequent* and *systematic* inspections to insure that his maintenance standards are being achieved. The informal command

inspection is by far the best means for obtaining maintenance information. Although the reports of subordinates should enable the commander to judge the results of his policy and directives, there is no substitute for the commander's *personal* estimate of the situation.

- ★ (4) *Enforcement.* Although the battery officers and NCOs are responsible for keeping the commander informed, they are not empowered to take formal corrective action. Enforcement of the maintenance policy lies with the commander, and he alone has the authority to enforce compliance with published directives. One of the most common mistakes made in maintenance is to blame the technician for failure when the real blame may be in an area beyond his control.

b. Role of the executive officer. The executive officer (XO) should be the battery officer responsible for the unit's preventive maintenance program. He, in turn, should assign specific responsibilities to other personnel and insure their coordinated effort.

- ★ (1) The battery executive officer, accompanied by the chief of firing battery and the field artillery mechanic(s), should make periodic spot-check inspections. He should inspect different parts of the weapons and motor carriages (or prime movers) with each inspection to insure complete coverage over a given period of time.

- ★ (2) The XO should periodically make a thorough mechanical inspection of weapons, motor carriages (prime movers), auxiliary equipment, tools, and spare parts.

- ★ *c. Role of the chief of firing battery/gunnery sergeant.* Under the supervision of the battery XO, the chief of firing battery/gunnery sergeant is responsible for the readiness of the battery's weapons and supporting equipment.

(1) He will keep the battery commander and XO informed concerning the efficiency of maintenance training and operation and the maintenance status of the battery's weapon systems and supporting equipment.

(2) He will insure that the section chiefs assign maintenance responsibilities to individual members of the crew in performing the necessary inspections and

maintenance of section vehicles and equipment. When a section is reduced in strength, he will insure that the section chief reassigns duties to see that all maintenance is performed.

(3) He will analyze the materiel readiness condition of the weapon systems and supporting equipment daily. He should know the expected delivery date for all repair parts on request for deadlined equipment and insure followup action is taken when a part is not received on time.

(4) He should insure, when possible, that deadlining parts are installed by battery maintenance or the FA mechanic prior to close of the duty day.

(5) He should require section chiefs to inventory basic issue items (BII) after each field exercise, or at least monthly.

(6) He assists the commander and XO in making informal and formal command inspections, and inspects vehicles and equipment periodically to insure that records are being maintained properly and that maintenance and repair work performed by the battery shop conforms to established standards. He makes recommendations to the commander for improvement as necessary.

- ★ (7) He supervises supply accountability for all weapon systems and keeps the XO informed of any equipment shortages.

- ★ (8) He insures that the appropriate publications are on hand in sufficient numbers to support the battery weapon systems maintenance and that all changes are posted.

- ★ *d. Role of the technician.* The battery commander has an NCO specialist assigned as his technical advisor. There is a tendency to blame the technician for maintenance failures, which implies a shifting of responsibility from the commander to his technicians. The technician must provide technical guidance, make recommendations concerning the preventive maintenance program, assist in the conduct of inspections, and assist in the preparation and conduct of preventive maintenance training. He cannot assume command responsibility.

e. Role of mechanics. All personnel who perform repairs and services on equipment, regardless of commodity group, are referred to as mechanics. They are the unit's last defense against multiplying maintenance problems.

- ★ (1) To be a mechanic worthy of the title, an individual must have the necessary technical training and be fully qualified on the types, makes, and models of equipment he is expected to inspect, service, and repair. Putting a man in fatigues, issuing him a toolbox, and assigning him to a maintenance shop does not make him a mechanic!

(2) Maintenance personnel must be motivated to do excellent work with a minimum amount of supervision. The end product of a mechanic's labor frequently is not apparent to visual inspection; however, disastrous results may follow careless performance of a service, a repair job, or an inspection. It is essential that each equipment operator and crewman have confidence in the mechanic and in the quality of maintenance performed.

f. Role of the section chief. Chiefs of section are directly responsible for operator and crew maintenance.

(1) They insure that operators, assistant operators, and crewmembers—

- ★ (a) Perform the preventive maintenance checks and services and repairs in accordance with the provisions of appropriate technical manuals.

(b) Listen and observe for abnormal equipment operation and record on DA Form 2404, Equipment Inspection and Maintenance Worksheet, all equipment faults that cannot be corrected.

(c) Clean and service equipment before putting it away.

(2) In addition, they must—

(a) Know the expected delivery date for all repair parts and inform the CFB/GSG of all parts that are not received by the expected delivery date.

(b) Inventory basic issue items after each field exercise or at least monthly.

- ★ (c) Spot-check equipment daily, when used, to determine any needed repair or adjustment.

(d) Insure that all equipment publications (TMs, LOs) are available and all changes have been posted.

- ★ (e) Using the PMCS tables, insure that the readiness condition of each section vehicle is updated whenever it is operated.

g. Role of the operator. The well-trained operator is the first line of defense against deteriorating equipment. If the commander can control the handling and operation of the equipment by the individual user and operator, he has found the key to prevention of equipment failures. Training and disciplining the operator so that he handles his equipment with "loving care" will reduce the commander's PM headaches.

18-3. How to Evaluate the PM Program

- ★ Normally, the first step a commander must take in evaluating his PM program is to review and analyze his existing organization. Are the portions of the overall job channeled to the appropriate elements within the unit? Is the unit responsive to available human, materiel, and time resources? Are the human resources properly organized? The commander must determine answers to these fundamental questions. If the answer to any of them is *no*, then the commander must find the reason and correct whatever deficiency exists. At the outset, the commander must isolate any problems he may have. This is not always as easy as it sounds. Since the commander is not a specialist, he may have need of some outside sources to assist him in isolating his problems. Three sources are listed here.

a. Maintenance assistance and instruction team program. The purpose of the maintenance assistance and instruction team (MAIT) program is to emphasize maintenance and to provide commanders with the necessary tools for isolating maintenance problems and achieving a high state of readiness. The MAIT program emphasizes practical application and provides the individual soldier with a clearer

understanding of maintenance techniques and procedures. Although the commander currently may be enjoying a high state of preparedness and readiness, he should periodically—at least annually—call his local MAIT chief and arrange for a visit.

b. Logistic assistance program (AR 700-4). The objective of the supply and maintenance assistance program is to provide assistance to commanders in resolving those supply and maintenance problems that are beyond the commander's capabilities to resolve with organic resources. Supply and maintenance specialists are US Army military and Department of the Army civilian personnel qualified to give assistance in the following areas:

(1) Assisting unit commanders in identifying and resolving logistic problems.

(2) Furnishing guidance and assistance to commanders who are responsible for conducting training to improve the skills of individuals responsible for, or associated with, materiel readiness.

(3) Providing maintenance management assistance designed to improve the skills and increase the capability of unit personnel in The Army Maintenance Management System (TAMMS), in preparation of materiel readiness and unit readiness reports, and in associated supply and maintenance management subjects.

c. Technical assistance. Technical assistance is the act of providing instruction and technical guidance to supported units by a direct support maintenance battalion. Its objective is to insure the correct interpretation and uniform application of maintenance and maintenance supply procedures in order to improve operations and conserve materiel. The battery commander may contact his supporting maintenance unit and make informal arrangements for assistance from the supporting unit.

The importance of the continuous evaluation of the maintenance program by commanders cannot be overstressed. The more complex equipment becomes, the easier it is for personnel to overlook equipment faults. The need for maintenance and maintenance inspection becomes greater all the time. The older equipment becomes, the greater the need for command emphasis. **DON'T NEGLECT YOUR PROGRAM.**

18-4. Establishing an Effective PM Program

Sound organizational maintenance programs can reduce requirements for time-consuming and expensive repair and services at higher categories of maintenance. There is no rigid pattern for establishing a PM program, but the lack of detail in regulations is never an excuse for inaction. FM 29-2, *Organizational Maintenance Operations*, provides some excellent suggestions the commander may wish to use. The program established will vary with many factors and it should be changed as the situation changes. A typical approach is outlined below.

a. Organization. Organization is the first consideration in establishing an effective PM program. The commander states the mission and functions and assigns tasks to key personnel. Responsibilities are fixed such that preventive maintenance performed on the equipment is the responsibility of a specific individual—usually the section chief.

b. Training. Maintenance and operator skills must be commensurate with the equipment authorized for issue to a unit and with the demands made by mission requirements. The commander must make maximum use of soldier's manuals and ARTEPs. Skills at the organizational level must be somewhat broad in scope in order to

identify problems and to isolate and diagnose failures. Most organizations are not authorized, for example, a fuel and ignition specialist, an optics specialist, or an electrician.

(1) Any unit needs depth in skilled personnel such as vehicle operators, weapons repairmen, radio operators, and supply clerks. Some degree of functionalized cross-training to attain depth is always beneficial. For example, automotive personnel who can repair both vehicles and generators add depth to a unit's maintenance capability. Since skills are closely related to practice and association with operational equipment, emphasis should be placed on restoring the proficiency of operators and maintenance personnel after an extended period of equipment inoperability.

(2) Skill depth should be compatible with the organization's concept of tactical employment. Some skills must be developed within an organization to insure effective operation of the unit even though a necessary MOS is not authorized.

★ (3) In many cases, school-trained personnel and school quotas are not available. If courses scheduled by the Army school system (see DA Pam 351-4) are unavailable or inappropriate, the commander must establish a well-supervised on-the-job training (OJT) program. In support of OJT, most service schools offer correspondence/OJT courses with standards that closely parallel those of resident courses. These courses assist the commander in conducting OJT programs that will increase the materiel readiness of the unit and, at the same time, provide a means for maintenance personnel to become MOS qualified and to progress to higher skill levels. Table J-1 (see appendix J) is a list of typical maintenance-related OJT programs and available correspondence courses.

★ (4) Many Department of the Army publications are available to assist commanders in training maintenance personnel. Some of these publications are useful as aids in establishing OJT programs; others are designed to assist commanders in establishing formal maintenance classes.

Table J-2 is a list of some of these publications.

★ *c. Operator training and supervision.* The operator is the key man in the entire PM program, and he must be trained to properly use and maintain his equipment. To qualify initially as an operator, a man must take a series of tests given by the local driver testing station and/or unit. The Department of the Army has a number of publications that set up the standard procedures for this initial selection and testing. These publications are listed in table J-3 and should be reviewed by all supervisors who influence driver selection and training.

★ (1) The initial testing is only a start point. Before a battery commander licenses an operator and assigns him to a vehicle, he should insure that the prospective driver understands all his responsibilities as an operator. In addition to the road test, there are many maintenance tasks that should be taught to the prospective driver before he is licensed. Many posts/units have schools that teach these additional operator tasks. In many cases, however, the commander will have to set up his own training program.

★ (2) Because of the continuing requirement to qualify new personnel as drivers or operators, it normally is not practical to establish battery-level classes in these tasks. The section chief should be the individual responsible for teaching these tasks in an OJT-type program before recommending the licensing of an individual. Given the proper amount of time (normally about 2 weeks), a section chief should be able to qualify his operators in these tasks during the regular battery maintenance periods. Table J-4 is a *suggested* list of tasks (in an OJT program format) that might be used to train a driver before he is licensed. Some tasks obviously do not apply to certain localities and should be disregarded.

★ (3) In some cases, the commander may feel that a more centralized battery-level effort is necessary. To aid in establishing his training program for operators, the commander/training officer might refer to the publications listed in table J-5 in addition to those listed in table J-3.

★ (4) Completing the driver training program and obtaining the SF 46 should be a challenge. The awarding of a driver's license indicates the battery commander's trust in the individual and the driver's acceptance of extra responsibilities. An imaginative commander will create incentives and rewards for those personnel willing to accept additional responsibilities. Such awards might include special passes and separate duty rosters for drivers (e.g., duty driver) and nondrivers (e.g., CQ runner and barracks orderly).

★ *d. Time and scheduling.* Army regulations require that commanders provide adequate time during duty hours for the performance of required preventive and corrective maintenance. Materiel readiness training must be as important as other personnel training and readiness. A proper balance must be maintained among training, maintenance, and all other requirements essential to combat readiness. Commanders must plan for the most efficient use of time available to individuals and to the unit as a whole. An organization's activities must be planned and organized to avoid haphazard use of maintenance time. The availability of personnel and their state of training will be a consideration in determining the time required and the allocation of available time for maintenance training and performance. Time means time for *training*, time for *inspections*, and time for *performance* of maintenance.

(1) *Time for equipment maintenance.* Time is one of the few constants that is a *must* in the maintenance effort. From accurate information on the number of man-hours devoted to maintenance, valid estimates can be made of the adequacy of many other factors that contribute to the total maintenance effort; e.g., skills, training, and facilities. The management of equipment maintenance costs can be related to the use of repair parts and man-hours expended in completing organizational repairs and services. It is worthy of note that the cost of Armywide maintenance efforts is assessed through determining man-hours recorded on maintenance records plus the dollar cost of repair parts derived from the number of

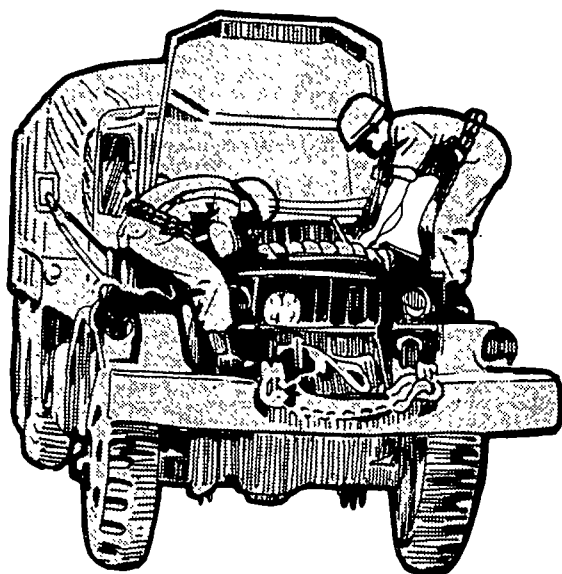
repair parts used and their identification by national stock number (NSN). Therefore, each commander and soldier working in the maintenance field should be impressed with the importance of accurately managing time consumed in the effort.

★ (a) The training schedule is one of the many tools the commander can use to emphasize equipment maintenance training. Training in maintenance—how it should be done—is important. The absence of maintenance periods from the training schedule will lead to emphasis on those scheduled subjects that do appear, with a resulting neglect of maintenance and combat readiness. The commander should also consider equipment other than vehicles when scheduling maintenance periods. He must insure that his section chiefs develop priorities to equate the most important functions to the amount of time available. For example, first priority should be given to maintenance of mission-essential materiel. The second priority might be on maintenance of non-mission-related items, and final consideration should be given to the maintenance of TA-50 equipment. Other subjects related to maintenance may be scheduled for personnel who have no direct responsibility for the equipment specified.

(b) Much time can be gained by properly integrating PM training into other unit activities. Two other *concurrent maintenance* areas that should concern the commander are the performance of maintenance by operators assigned to equipment as an in-addition-to duty and the performance of maintenance during road marches, tactical problems, and other field training. The commander's policy for each of these conditions can be adequately stated in the unit maintenance SOP. The absence of a stated policy on concurrent maintenance services and in-addition-to maintenance duties almost always will lead to equipment maintenance problems.

(c) Making time available for *operator services* provides an incentive for better preventive maintenance. Each job assigned an equipment operator should allow for the

distance or hours of operation, permit inspections during the operational period, and allow adequate time for after-operation services. A unit is asking for trouble if the end of an operational period runs into "chow time" too frequently. Time for at-halt inspections is essential for tactical and combat vehicles during a tactical march. Precautionary measures and performance indicators, which are important during equipment operation, *must* be stressed in operator training for all types of equipment.



(d) Each -20 technical manual and lubrication order for an item of equipment states the requirements for *periodic services*. The requirements may be given in terms of miles, hours, or a calendar period. A schedule will be prepared by the using unit for every item that requires a periodic service. DD Form 314, Preventive Maintenance Schedule and Record, is used for this purpose. The important management aspects of scheduled PM services are that they are completed on time and are performed according to the published instructions in the technical manual. The due dates and time allotted for these services must be controlled by supervisors in order to distribute workloads evenly for maintenance personnel.

(2) *Time for inspections.* Commanders must make time available for personal inspections. Also they should be aware of the

maintenance man-hours being devoted to equipment inspections and the timing of inspections as they relate to other activities of a unit. When the commander plans to conduct a personal inspection, he should consider what he wants to observe and the unit activity; for example, a unit mess that has just returned from a 10-day field training exercise (FTX) rarely will have its mess equipment prepared for inspection the following day. The commander should conduct his inspection after supervisors and noncommissioned officers have had a reasonable amount of time to get the equipment in shape. Commanders should make the best use of their own time by using PM indicators for equipment.

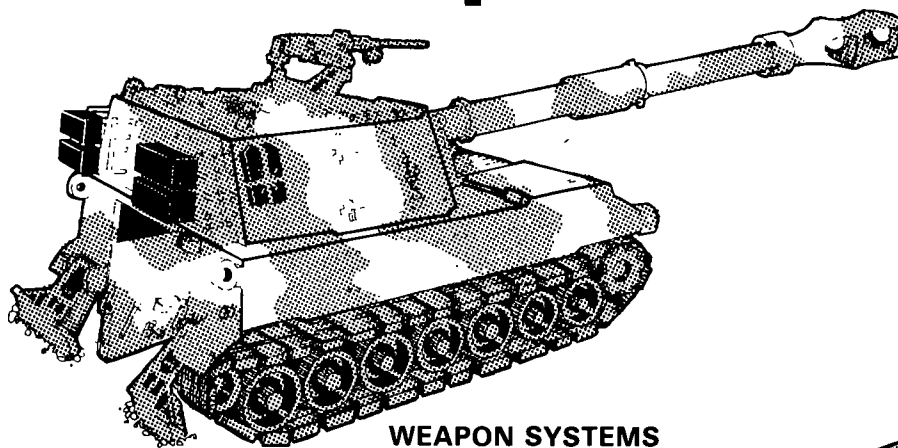
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(3) *Priority of effort.* Progress is the keyword in any effort. Tasks should be assigned through the chain of command according to priorities that will achieve the most overall progress. Although the commander's estimate is a continuous process and decisions as to courses of action change frequently, an operator or mechanic should be permitted time and provided resources to complete one task before beginning another. Enough personnel and materiel resources should be concentrated on a course of action to insure its success.

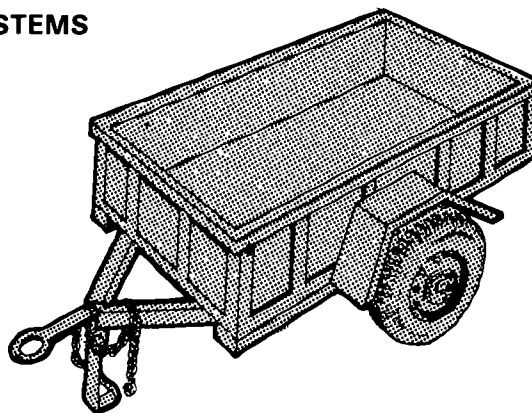
★ MAINTENANCE PRIORITIES

I



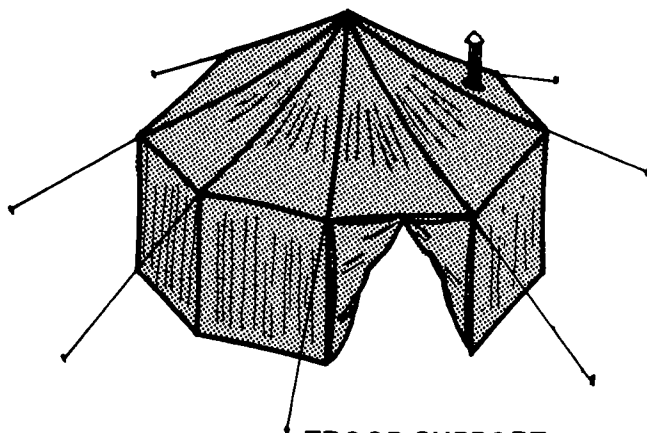
WEAPON SYSTEMS

II



SUPPORT OF WEAPON SYSTEMS

III



TROOP SUPPORT

★ Commanders must recognize that it is not realistic to expect every item of equipment to be available for use 100 percent of the time. If, after all requirements have been considered, there is just not enough time for complete maintenance, serious consideration should be given to placing some equipment in administrative storage. It will require maintenance services, but not as much as it would in active use. Proper care is part of the price that must be paid for the benefits derived from modern military equipment.

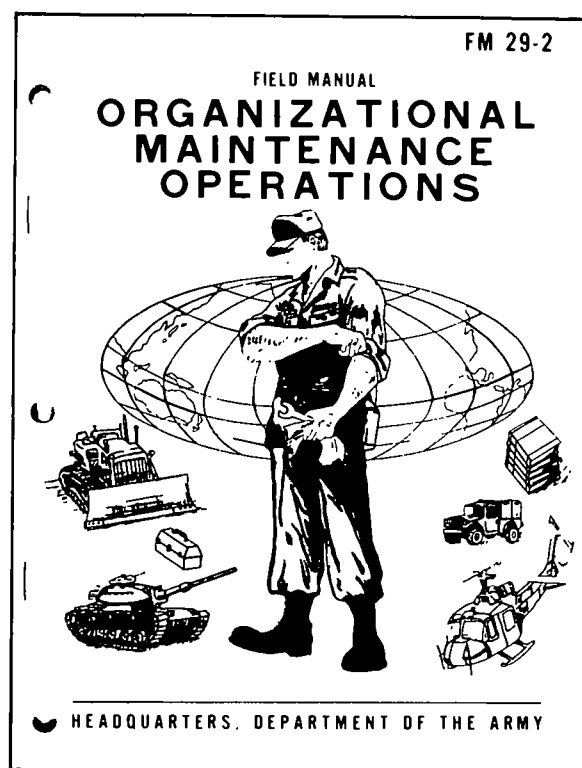
(4) *Identification of problem areas.* Forewarned is forearmed; therefore, problem areas must be identified before serious inroads can be made into the entire organizational maintenance program. The training schedule or even just the calendar—a projected field exercise or expected bad weather—can signal the advent of maintenance problems. Some examples of indicators that should warn a commander of problem areas are:

- (a) Low ratings in inspection reports.
- (b) Notable shortages or overages of repair parts and expendable supplies.
- (c) Accidents and frequent equipment failures.

e. Maintenance procedures. Sound, workable standing operating procedures are absolutely essential to the success of tactical operations and administrative and logistical procedures. SOPs are important to the success of organizational maintenance functions, whether the unit is in garrison or in the field.

★ (1) *Preparation of an SOP.* The preparation of an SOP or a change to an SOP requires planning and coordination within the organization. FM 29-2, *Organizational Maintenance Operations*, has an excellent format for developing a unit SOP. An SOP should be prepared at each command level, including the battery. It should be printed in the most effective and convenient form and updated as necessary.

(2) *Delegation of authority.* Maintenance responsibilities and functions must be assigned. Each individual must know where



he functions in the overall plan; e.g., who is responsible for approving entries on DA Form 2408-14? The XO, the chief of firing battery, the motor sergeant—or all of them?

f. Repair parts supply operations. Specific repair parts requirements are generated by equipment failures and repair actions. The unit concerned is fortunate indeed if the necessary repair part is immediately available in the bin or on the shelf. The repair parts and common hardware that an organization should have on hand are those that are authorized to the unit and are needed most often to correct failures experienced in the unit. AR 710-2 governs supply procedures at the organizational level. Repair parts requirements are specific; the paperwork to obtain the parts is specific. Cyclic actions to process the paperwork must be followed in a routine order if supply procedures are to be responsive to unit needs.

(1) Interference with, or interruption of, supply routine and unit supply personnel must be kept to a minimum. Supply tasks are not difficult, but they are rigid and sometimes tedious and require the individual attention of supply personnel.

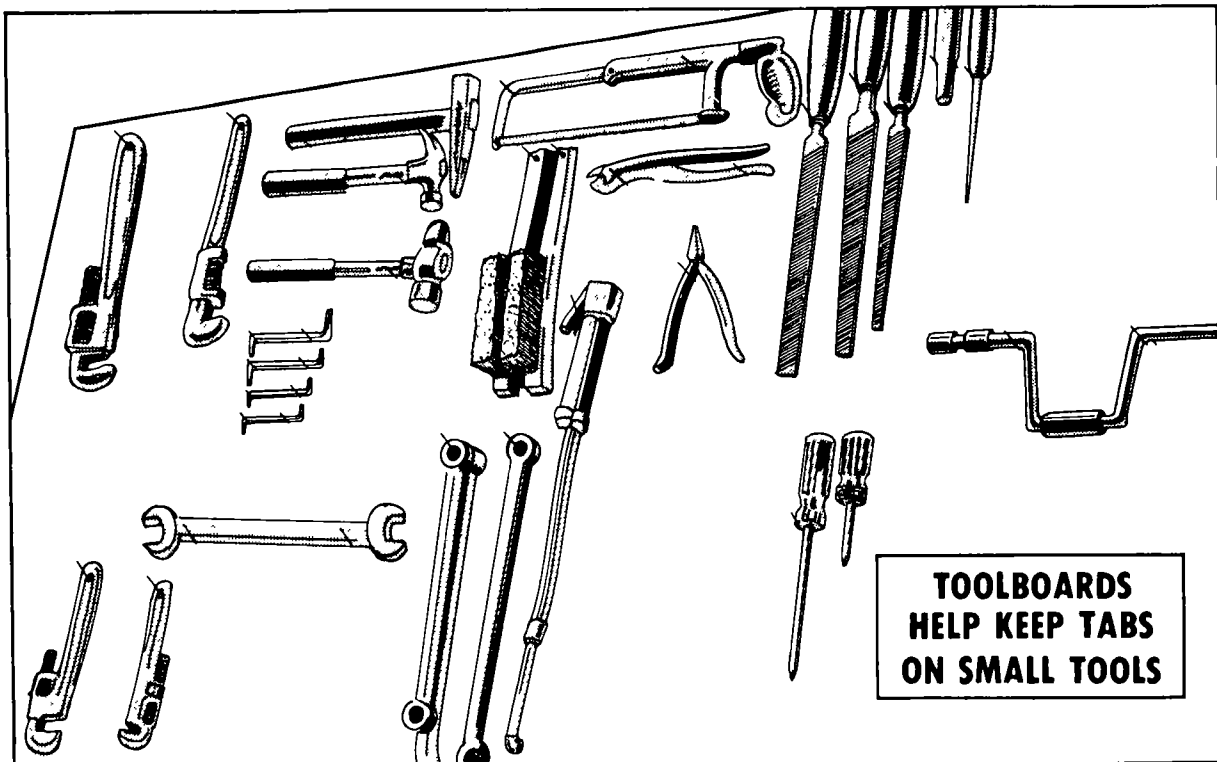
(2) Ignorance of published procedures is in fact an abuse of the supply system. Without a systematic routine, supply personnel will find many of their efforts unproductive, will receive excessive cancellations to requests, and will duplicate efforts unnecessarily.

g. Facilities and equipment. Effective maintenance requires the availability of adequate facilities. This means shelter, heat, light, and adequate power for the shop. Maintenance facilities available will vary depending upon the location and the activity. In garrison, maintenance personnel normally will have adequate facilities if the needs are explained and justified and requests for facilities are followed up. This sometimes requires ingenuity and imagination. One of the greatest deterrents to effective preventive maintenance is the lack of reasonably comfortable facilities. It is difficult to tighten and adjust equipment with cold fingers or to work in the dark. If conditions are not comfortable enough, maintenance may be performed improperly or left completely undone.

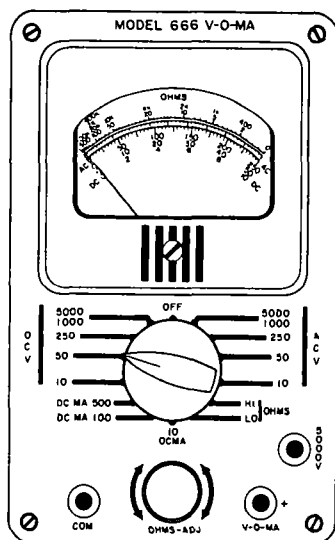
h. Tools and test equipment.

★ (1) Attempting to maintain equipment without the appropriate tools, repair parts, and facilities is both frustrating and nonproductive. The Army maintenance system provides the tools and test equipment necessary for performing the organizational maintenance mission. The completeness of tool sets is critical. Missing and defective tools often are the cause of ineffective or insufficient preventive maintenance. A system is needed for the control and assignment of tools and equipment, and there must be provisions for orderly storage, protection, and availability of all tools and equipment. PS Magazine 292, March 1977, has an excellent article outlining these procedures. Detailed information on the care, preservation, and storage of tools and tool sets is published in technical manuals, technical bulletins, or supply bulletins. Each organization should refer to the list of publications under "tools" in current indexes. This will help to determine whether current, applicable publications are on hand for the tools and tool sets authorized.

(2) Organizational tool sets are designed for use by several mechanics. An organizational tool set that shows no signs of



normal wear probably is not being used. Normally, these tool sets contain items of test equipment that are authorized for checkout and diagnosis of equipment failures. Commanders inspecting maintenance shop operations should pay particular attention to the availability, calibration, and use of test equipment. The unit maintenance personnel should be queried on their familiarity with this test equipment. Tactical units should have provisions for orderly storage, protection, and availability of all tools in the field as well as in garrison.



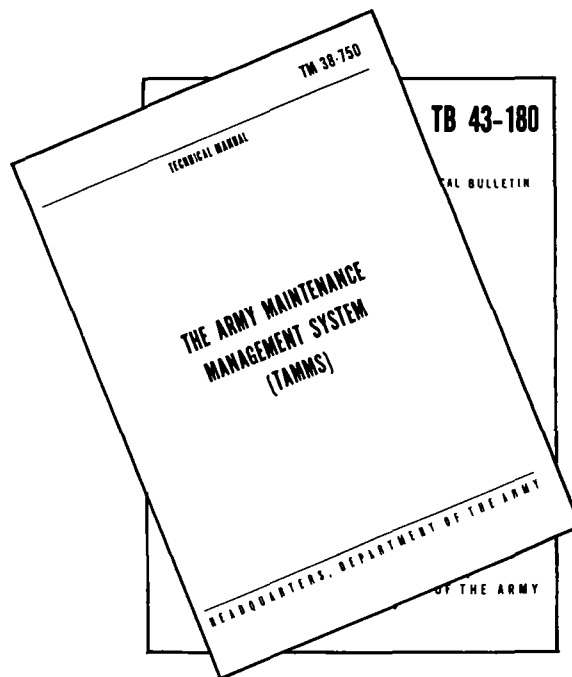
- ★ (3) With today's highly sophisticated equipment, calibrated test equipment is very important to the commander. TB 43-180, *Calibration Requirements for the Maintenance of Army Materiel*, is the "bible" for calibration—the single authoritative document for identification and establishment of calibration requirements—and applies to all US Army units. TM 38-750, *The Army Maintenance Management System*, prescribes the forms and the "how to" of the calibration program.

i. Publications. The performance of maintenance, either preventive or corrective, on complex Army equipment depends on the prompt receipt of administrative and technical publications. No individual is expected to know the number and title of every publication pertaining to the equipment in his unit. However, it is necessary that everyone knows how to determine which publications are needed. A

knowledge of the publications system will help the commander insure that his unit is receiving proper publications distribution and support.

- ★ (1) Despite the effort and expense involved in the Army's vast publication system, there is a common failure to get publications into the hands of the user. Sometimes this failure can be blamed on the system itself, but more commonly it is a failure at organizational level to know what is required and to take the simple step of preparing a request (the commander should insure copies of DA Pamphlet 310-10, *Guide for Publications Supply Personnel*, and Misc Pub 18 are available for reference purposes). For this reason, each commander should, during unit inspections, check to determine whether the appropriate publications are available to the men who need them.

(2) Official DA publications that most directly affect organizational maintenance are regulations, circulars, field manuals, pamphlets of the 750-series, technical manuals, supply manuals, technical bulletins, lubrication orders, modification work orders, and supply catalogs.



- (3) The commander must insure that the subscription forms of the DA Form 12 series (listed in table J-6) are completed by his unit to indicate the types of publications needed and

the quantities required to accomplish the unit mission.

★ (4) The more thought a unit gives to stating its requirements on the DA 12-series forms, the less work someone will have to do in requisitioning. If the unit's DA forms of the 12 series are correct, the publication officer or NCO will have little or no need to submit DA Forms 17 or 4569 for ARs, FM's, etc. The unit will receive all needed publications automatically. Pinpoint distribution was created to relieve the unit of trying to keep up with new publications as they are issued and then requisitioning those items.

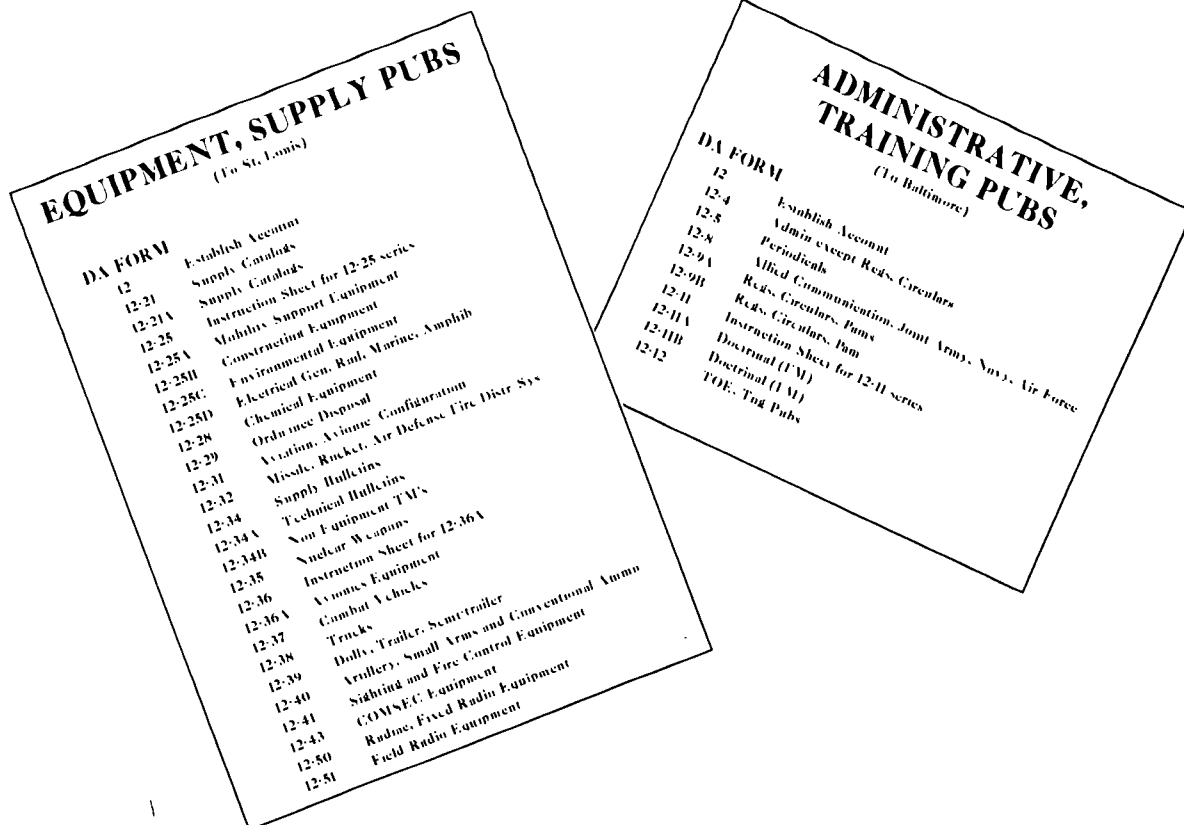
(5) Publications must be kept current. In accordance with AR 310-2, all organizations are required to review their existing subscription forms (12-series) periodically, at least twice a year and/or upon change of commanders. The review will be recorded, and review results will be filed at the unit and attached to DA Form 12 record copies.

(6) Each battery should maintain a library of current publications for ready reference purposes by all personnel in the

unit. Some consideration should be given to the number of libraries required to support the unit mission. A library of current maintenance publications required by operators and maintenance personnel must be maintained in the battery shop. Consideration may be given to establishing an MOS-related library in the training room. Paragraph J-5 is a suggested list of publications required by a battery maintenance section.

(7) *PS Magazine* is a pocket-size, cartoon-type magazine published monthly by DA for the information of organizational maintenance/supply personnel. It is clearly written in informal, everyday language and is a valuable source of information pertaining to preventive maintenance.

★ (8) DA Pamphlet 750-1, *Maintenance Guide for Leaders*, is a guide for the commander. Chapter 1 is concerned with the philosophy of maintenance, and the remainder of the pamphlet contains illustrations of PM indicators for common items of equipment.





pamphlet contains illustrations of PM indicators for common items of equipment.

j. Maintenance records and reports. Maintenance records and reports are needed for information and management purposes. The action taken, based on records or reports, is intended to benefit each equipment user and the entire PM program.

k. Inspections. Continuous observation of the PM program is required. This may be considered a matter of supervision or a matter of inspections; however, everybody must be constantly on the lookout for practices and conditions that help or hinder the program.

(1) Operators inspect the equipment on a continuing basis.

(2) Section chiefs inspect both the equipment and the operator to insure that proper tools and methods are being used to secure the best possible results. They provide advice and assistance as needed.

(3) Unit commanders inspect procedures to insure that personnel are following the

SOP and that desired results are being achieved. Officers cannot be expected to be completely knowledgeable in the detailed operation of the equipment, but they must be able to recognize satisfactory performance and maintenance through PM indicators. They should be particularly critical of the Preventive Maintenance Schedule and Record, DD Form 314, to insure that "paper maintenance" is not being performed. Officers should prepare themselves before inspections in order to insure that a thorough inspection of the unit will be made.

18-5. Using Key Personnel to Implement the PM Program

It is true the commander is responsible for all matters relating to mission accomplishment, discipline, training, welfare, and control of the men in his unit. He must supervise and insure timely completion of all battery activities, including providing command guidance to the motor officer, directing implementation of the maintenance program, and supervising the execution of the program. However, the commander who does not take into consideration the proper use of key personnel is being nearsighted, and his maintenance program will eventually suffer. Listed below are some tasks key personnel must perform to insure an effective PM program.

a. Executive officer/motor officer.

(1) Plans and implements the battery maintenance program.

(2) Advises the commander on the status of the maintenance program.

(3) Recommends solutions to identified maintenance problems.

(4) Makes changes as directed by the commander.

★ (5) Assists commander in monitoring operator's daily inspection of vehicles, using the user's manual preventive maintenance checks and services (PMCS) tables to insure readiness condition.

- ★ (6) Analyzes DA Form 2406, Materiel Readiness Report, and briefs the commander.
- ★ (7) Insures pinpoint account (DA Form 12 series) is reviewed every 6 months and the results are on file.
- ★ (8) Analyzes the maintenance program in accordance with FM 29-2, paragraph 4-3.

b. Chief of firing battery/gunnery sergeant.

- (1) Advises XO on problems affecting the maintenance program.
- (2) Provides planning recommendations to XO on the allocation of all resources.
- (3) Insures that crewmembers are available for scheduled services.
- (4) Recommends maintenance standards to support mission accomplishment.
- (5) Assists the XO in the execution of the section operator/crew maintenance program.
- (6) Insures the availability of needed expendable supplies to support the operator/crew program.
- (7) Insures cannon sections comply with the unit SOP.
- (8) Supervises the cannon section maintenance program.
- (9) Maintains cannon section equipment status report.
- (10) Insures that cannon section operators are trained and licensed properly.

- ★ (11) Insures DA Form 2408-4, Weapon Record Data, is closed out by the battery commander and new form is initiated before forwarding the old form in accordance with TM 38-750.

- ★ (12) Coordinates services due on weapons.

c. Motor sergeant.

- (1) Under supervision of the motor officer, implements the unit maintenance program.
- (2) Advises the motor officer on the unit

maintenance program and mechanic training.

- (3) Conducts MOS refresher training for maintenance personnel.

- (4) Executes changes as directed by motor officer.

- (5) Verifies faults reported by operator/crew personnel.

- (6) Determines cause of failure, if possible, and recommends corrective action.

- (7) Prepares and maintains an equipment status board.

- (8) Prepares and maintains a daily workload schedule.

- (9) Spot-checks operator/crew maintenance and reports deviations from standard to the commander.

- (10) Inspects or supervises inspection of equipment to insure that proper PM services have been performed.

- (11) Supervises diagnostic testing of procedures on unit equipment.

- (12) Controls special tools and test equipment.

- (13) Insures that maintenance personnel are thoroughly briefed on maintenance/safety SOP.

- (14) Monitors driver training.

- (15) Inventories common and special tool sets monthly.

- (16) Inspects tools weekly.

- (17) Coordinates with chief of firing battery daily.

- (18) Insures timely evacuation of equipment.

- (19) Insures that all repair parts requests are submitted to DSU at least once daily.

d. Chief of section.

- (1) Insures that assigned drivers and alternates are properly trained and licensed.

- (2) Insures that proper TMs and forms are available with the equipment and that latest changes have been posted.

★ (3) Checks and reports to the chief of firing battery the operational and readiness status of equipment.

(4) Knows when services and lubrications are due on equipment according to logbook and hours/miles of operation.

(5) Trains each crewmember in performance of before-, during-, and after-operation services.

(6) Supervises assigned crewmembers in performing before-, during-, and after-operation service in accordance with the equipment TM.

(7) Informs chief of firing battery of all uncorrected faults.

(8) Insures crewmembers adhere to maintenance/safety SOP.

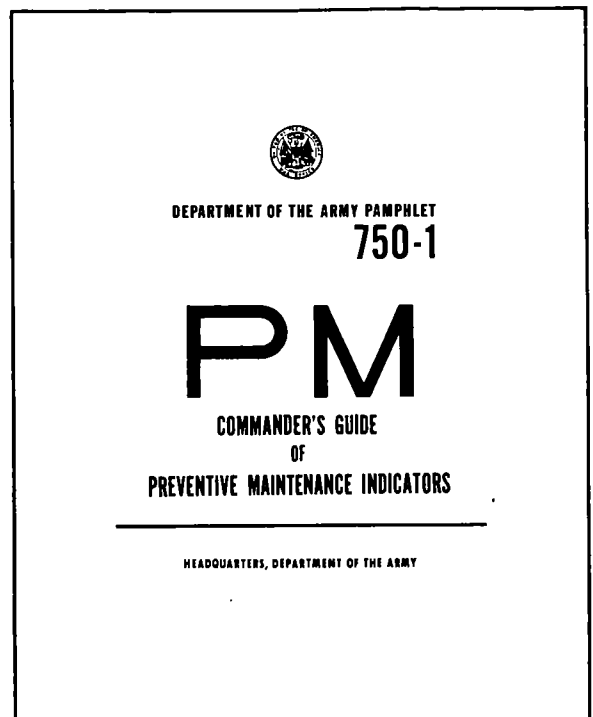
(9) Knows the expected delivery date for any repair part on request when his equipment is deadlined.

18-6. Using PM Indicators to Evaluate the PM Program

The term "PM indicator" is used to describe key features of personnel, materiel, supplies, procedures, and facilities, the known condition of which will indicate the quality of preventive maintenance. The formal definition of the term is "an area of possible failure or malfunction in equipment that can be detected by localized application of the sense of sight, sound, touch, or smell and indicates the condition and the quality of maintenance."

a. Selection of PM indicators. Prior to an inspection, a commander should determine which items of equipment or maintenance functions he is going to inspect. Using TMs, LOs, and other publications, he should then select two or three indicators for each item and become thoroughly familiar with them. This will develop a feeling of confidence and impress personnel of the inspected unit with his interest in maintenance. Different indicators for the same equipment should be selected for succeeding inspections so that personnel will not fall into the habit of maintaining only what they know will be inspected.

b. Use of PM indicators. The program of PM guides for commanders (DA Pam 750-1 and AR 750-1-2) has been established by the Department of the Army to provide consolidated preventive maintenance information for use by any commander. Preventive maintenance guides can assist the commander in estimating preventive maintenance requirements, in planning and managing a preventive maintenance program, in instructing subordinates, in scheduling and conducting inspections, and in *evaluating the effectiveness of the PM program*. During an inspection, commanders should always remember that the most important indicator is the item's performance and the probability that it will continue to perform satisfactorily based on the care it is receiving.



(1) Deficiencies found should be related to the cause.

(2) Elimination of the cause should be the commander's primary concern, since this will reduce that type of deficiency in the future.

(3) The source and cause most often can be found and corrected within the unit.

(4) If some outside (backup) support is the problem, command action may be required to relieve the problem.

c. General equipment PM indicators. Equipment PM indicators are, in most cases, detailed and specific and enable the commander to know precisely what to look for. However, in addition to specific equipment indicators, there are several PM indicators that may have a general application to many types and categories of equipment. The commander should be alert for evidence of the general indicators. The following fall into this category.

(1) *Adjustments.* Proper tolerances, clearance, and travel are required in many areas. Evidence of chafing, binding, cracking, rips or split seams, and erratic operation indicates improper adjustment. Frequently, improper adjustment may be quite evident in the amount of play in belts, pulleys, levers, or gears and in the amount of lateral movement that can be felt in bearing adjustment. Often, improper adjustment is quite apparent in such items as canvas and webbing.

(2) *Color and marking.* Bright colors are used in the areas of caution or safety. For example, yellow is used on the tips of aircraft propellers to warn personnel to keep clear. Black and yellow stripes are painted around grease pits to caution personnel. Decals and data plates contain very specific, purposeful information, and those that are missing or illegible should be replaced. Labels are important on many chemical and medical items, since discoloration may indicate deterioration. Discoloration of fabrics may indicate deterioration due to mildew, rot, acid burns, or just plain wear. Generally, color codes are applicable for various types of ammunition, high-pressure tubing, and electrical circuits. Certain areas, such as rubber tubing or lubricated metal surfaces, should never be painted.

(3) *Cleanliness.* Cleanliness, as related to maintenance, must be considered from the standpoint of its effect on the proper functioning of the equipment. Dirt may conceal deficiencies and shortcomings and result in further damage to the item.

Functional surfaces should be generally free of foreign matter so that cracks, dents, corrosion, or rust can be detected readily and will not interfere with the proper operation or function in such areas as metal-to-metal bearing surfaces, cooling surfaces, filters, or areas requiring lubrication. Fuel and lubricant leaks create safety hazards. The accumulation of foreign matter, grease, and oil cannot be tolerated in areas subject to fire. Cleanliness must be directly related to the environment in which equipment is used; e.g., the accumulation of rust is permissible in such areas as cannon tracks, mufflers, and exhausts. On the other hand, medical equipment must be sterile and must be free of stains and alkali deposits, and rubber must be free of oils, fats, and greases, which cause rapid deterioration. Although a clean piece of equipment is not necessarily well maintained, well-maintained equipment is always clean.

(4) *Equipment records.* Equipment records must be up to date, legible, and accurate and must indicate the true status of equipment. Outstanding MWOs, other deferred maintenance, and the number of uncorrected faults—along with the supply action and timely scheduling of maintenance—can be determined from equipment records as an indicator of an effective maintenance program.

(5) *Lubrication.* Lubrication orders should be on hand and in active use. No grittiness or binding should be evident in bearings or areas requiring lubrication. Grease fittings should be clean and clear, and the proper tools (such as purging tools and needle-nose adapters for flexible nozzle grease guns) should be on hand.

(6) *Safety features.* Compliance with commonsense safety requirements is a sound indicator of a good PM program. Fire extinguishers, emergency exits, and safety devices should be easily accessible and conspicuously marked. Containers for poisonous or flammable liquids must be isolated and properly labeled. Lacing wire, cotter pins, tang washers, safety pins, etc. should be present where needed and properly installed. Electrical grounding systems must

be of an approved type, in place, and secure and must provide a positive ground. Warning systems, buzzers, or lights should be tested to insure proper operation. The commander should observe for the presence of protective clothing, guards, shields, or screens, where appropriate, to preclude injury.

(7) *Smell.* A commander should be alert for the presence of unusual odors. Abnormal odors may be due to electrical circuits shorting out, overheated motors or other components, lubrication failures, or leaks. A strong smell of gasoline or other fuels should not be present. Mildew, mold, or rot due to prolonged storage in confined areas gives characteristic odors that should be investigated.

(8) *Stowage.* Most major items are used with some ancillary or basic issue list items of equipment, and the methodical stowage of such material is indicative of good preventive maintenance. The commander should ask to see the packing list or a stowage plan. The location and positioning of tools, accessories, and repair parts in stowage must be protected from damage and deterioration. Any stowed equipment must be serviceable. Doors, catches, hinges, and handles on stowage compartments must be secured and functional. Silica bags should be present where moisture must be removed from stowage compartments. Napthalene crystals should be used to avoid insect damage to fabric. Periodic, routine airing of canvas, camouflage nets, and blankets is needed to prevent mildew and mold.

18-7. Factors Affecting the PM Program

No organization or unit that performs its own organizational maintenance is too small to perform some maintenance management functions. A commander's evaluation of maintenance management within his organization is equal in importance to the determination of the status of equipment. The management factors of maintenance, at one level or another, are generally the sources to which equipment problems can be traced. Inspection reports and readiness reports usually can indicate the presence of

problems; however, the commander must identify which of the following factors that affect maintenance is the weak spot in the particular maintenance situation.

a. Repair parts. An organization's ability to complete its maintenance actions promptly and its capability for independent operations are closely related to its prescribed load of repair parts. Usage data must be carefully analyzed and the PLL expanded, as required, on the basis of demand history. An organization that is not forecasting and requesting repair parts on the basis of seasonal or anticipated requirements is causing further impairment to the maintenance program.

b. Tools and test equipment. Usually, tools and test equipment are taken for granted. Most commanders are unconcerned about this area of maintenance, because it is assumed that nothing can go wrong with a wrench. Unfortunately, some commanders find out that abuse or loss of tools (lack of accountability) or an absence of personnel trained to use the tools can significantly affect their maintenance program. It is far better to initially devote a little attention to the area of tools and test equipment management than to be unpleasantly surprised by a critical situation requiring the use of a missing tool.

c. Time. The key aspect of time is proper use. Improper use results from improper planning. The commander will often note that the first hour in his motor pool is one of mass confusion. Many hours are lost because of a lack of direction. Scheduled maintenance periods (motor stables) are often a waste of time. The troops spend more time wiping fenders than maintaining equipment. The commander must insist that the section chief develop a plan for maintaining his equipment prior to these scheduled maintenance periods.

d. Facilities. All personnel should constantly seek ways to improve all facilities in the command. One very effective way of showing command interest is through improvement of existing facilities. Sometimes, soldiers are not so much concerned with what has been done for them

as they are with the fact that someone is *trying* to do something for them.

e. Personnel. All personnel must achieve a degree of proficiency that will cause them to have complete confidence in themselves and in their ability to perform assigned tasks effectively. Just as important, all personnel should have an ongoing educational program oriented toward self-improvement.

f. Publications. It is one thing for a unit to know what publications should be on hand for use. It is altogether another matter to actually have these publications in the unit. The equipment in today's Army is a mixture of many different and complex items. Trying to maintain this equipment without publications is an exercise in futility.

g. Command. Every commander knows that he is responsible for everything his command does or does not do. This applies to maintenance. *Command responsibility* is a sound principle but in practice can become little more than a vague generality. This is especially true in terms of maintenance management. Only the commander himself can make this factor, and consequently all the others, work in his favor.

18-8. Maintenance Management Indicators

Initially, the commander may have difficulty in identifying a starting place. Listed below are some suggestions the commander may use until he develops some indicators of his own.

a. Personnel availability and assignment.

(1) Ask the NCOIC or activity supervisor for a status report of personnel. This information should be available on a status summary sheet or board for all but the very small units. Unknown personnel status or an out-of-date summary indicates poor management.

(2) Compare MOSs authorized to MOSs assigned. Discrepancies should be investigated. Ready, accurate responses to the commander's queries about skills indicate good management.

(3) Determine the approximate

percentage of productive time a maintenance man spends on his primary job. Low productivity due to administrative procedures, details, and inspections or unrelated training indicates poor command supervision.

(4) Commanders and supervisors must forecast needs for skills and know procedures for obtaining proper replacements. Inquire about projected losses and actions taken to provide skilled replacements. Poor maintenance management is indicated by a lack of a personnel replacement request for assigned maintenance personnel who have reassignment orders.

(5) Query maintenance personnel about their schooling, past experience, and job proficiency. Answers reflecting a lack of training or proficiency should be followed up by further queries as outlined in *b* below.

(6) Determine whether mechanics performing operator and/or higher category maintenance are interfering with the completion of authorized organizational maintenance. If so, poor command supervision and maintenance management are indicated.

(7) Conduct a random check of operator permits for proper qualification.

(8) Determine the qualifications of key individuals in readiness positions. Since the vastly increased power of the Army is derived chiefly from the readiness of our equipment, it is only reasonable to assign the best qualified individuals available to materiel readiness functions.

b. Training activities.

(1) Determine whether maintenance personnel are school trained in the MOS of assignment. Negative responses indicate a need for on-the-job training programs or initiation of requests for school quotas.

(2) Examine current training schedules to determine whether maintenance training is scheduled. If so, determine whether it is scheduled to fulfill a certain organizational need or is directed by higher headquarters. Determine who prepares and teaches classes.

Positive, purposeful instruction, although the amount of time devoted may be limited, indicates a good training program.

(3) Ascertain the manner of task assignment. Teaming experienced skilled personnel with helpers or newly assigned men indicates planned efforts to raise skill levels.

(4) Observe work in progress for presence of operators or crews with equipment in organizational maintenance shops. Presence of operators and crews indicates emphasis on practical maintenance training and raising operator proficiency.

c. Shop organization and procedures.

(1) Examine procedures for scheduling and accepting equipment for services and repair. Determine whether there is a system of assigning work to mechanics. The supervisor of an efficient shop always should know the status of equipment in the shop and the amount of maintenance workload.

(2) Check the chain of command—a mechanic should not be required to take orders from more than one supervisor.

(3) Observe the processing of paperwork and flow of equipment records. Bottlenecks in paperwork indicate overcentralized administration. If equipment logs or maintenance worksheets that require entries by mechanics are not with the equipment when it is being repaired or serviced, duplication of paperwork or loss of maintenance information is indicated.

(4) Examine bins, stalls, or areas where repair parts are kept. These areas should provide adequate space for temporary storage. Parts should be easily identified and marked for a particular major item. Old dates of receipt (4 to 5 days) entered on shipping documents or parts to be installed indicate poor management, lack of personnel, or insufficient time for maintenance.

d. Tools and shop layout.

(1) Tool authorization documents for organizational, special, and individual sets and/or current lists of tools on hand, short, and on requisition indicate good shop

management. (Back issues of *PS Magazine* contain some very helpful illustrated lists.)

(2) A well-organized shop must make special tools and test equipment available to each mechanic, but the unit also must have a workable system for tool checkout, return, and safeguarding while tools are not in use. Shadow boards for tools indicate a shop concerned with tool care.

(3) Indicators of poor tool maintenance are loose wooden handles, broken screwdriver tips, mushroomed heads on drifts and chisels, lubricants on files, and broken or rounded-out wrenches.

(4) Shop layout depends largely on the geographic location or on buildings, rooms, and other physical facilities, such as grease pits (or racks) and wash areas. Work areas should be located to minimize interruption by outsiders. The main entrance should lead to the shop office or to the maintenance supervisor's desk if the shop is in one room.

(5) Indicators of a good shop layout are readily accessible technical publications, workbenches, lubricants, cleaning materials, electrical outlets, common hardware, tools, and trash cans. Temperature, lighting, and ventilation should be at least adequate.

e. Repair parts supply.

(1) If DA Forms 3318, Record of Demands-Title Insert, are maintained, examine five or six of them and note if authorized stockage is on hand or on order. Write down the NSN and on-hand quantity for each item. Compare the on-hand balances to quantities present in repair parts bins. Inspect for proper identification and storage to prevent damaging parts. Failure of quantities entered on records to agree with physical count or storage of unserviceable or damaged repair parts indicates poor repair parts management.

(2) Inspect the Document Register for Supply Actions (DA Form 2064) for entries approximately 30 days old showing parts requested and not yet received. Determine whether the parts are still due out to the organization or have been received and the document register entry has not been

completed. Determine if the parts clerk is reviewing the monthly consolidated listings. Incompleted entries indicate poor repair parts administration.

(3) Examine repair parts requests that have been prepared but not yet submitted to the supporting supply activity. A time lapse of more than 3 or 4 hours for a deadlined item or 24 hours for a nondeadlined item between the initiation of the repair part requirement (e.g., a DA Form 2404 prepared by an operator or a mechanic) and the time the parts request is made indicates a mediocre repair parts supply operation.

(4) Check for the "hanger queen," a nonoperational item used as a source of parts exchange to avoid following proper resupply procedures. Prolonged deadline status and parts cannibalization by units indicate failure to follow the prescribed system and/or a lack of confidence in supporting activities.

f. Maintenance and equipment records. There are infinite possibilities for equipment records to reflect the proficiency of organizational maintenance. Only three indicators will be listed here. If a more detailed inspection is considered necessary, use of the three indicators cited should lead to other equipment records that will confirm or alter the initial findings.

(1) Inspect copies of DD Form 314, Preventive Maintenance Schedule and Record. A properly prorated, current maintenance schedule indicates a good PM program. Inked-in dates recording completed services should be current within 10 percent. Proration of scheduled services should distribute the maintenance workload equally over a given period. For future reference, the serial or unit numbers of five or six items due or undergoing a periodic service should be noted. Ascertain if supervisory personnel have forecasted known component replacement items (e.g., fuel filters, oil filters, and seals) and requested required quantities from support activities. Failure to forecast needed requirements indicates poor maintenance management.

(2) Review several completed Equipment Inspection and Maintenance Worksheets,

DA Forms 2404, prepared for recent operational periods or scheduled maintenance services. Information required by blocks in the heading (e.g., mileage, hours of operation, technical publication(s), and date) should be complete. Equipment faults entered should be clearly described by the operator or mechanic. Check the forms for items that have recently undergone a PM service ((1) above). Determine how many operator/crew-type faults were found and corrected by the mechanic. Excessive operator faults detected indicate a need for additional training.

(3) Inspect several DA Forms 2408-4, Weapon Record Data. Ascertain if rounds fired are being maintained by zone. Determine if maintenance actions are being related to rounds fired; for example, the torque key on the M109A1 howitzer must be measured after each 1,500 rounds fired regardless of zone. If personnel cannot determine the total rounds fired or cannot relate maintenance actions to rounds fired, a lack of management is evident.

☆ (4) Inspect several DA Forms 2408-18, Equipment Inspection List. Ascertain appropriate inspection points are listed and that inspections are being performed in conjunction with the number of rounds fired as prescribed in the listed publication(s).

g. Publications. Publications attain principal importance as a maintenance management indicator because the use of outdated publications, or lack of certain publications, results in improper procedures or trial-and-error maintenance.

(1) First, insure that the shop office has a system for reviewing and requesting required publications. A copy of DA Pamphlet 310-4 with the latest published change must be on hand. Briefly scan the latest change and look for marginal checks or notes by the most recently published, rescinded, or superseded TM, TB, or LO. Such marks indicate that a review has been made to determine if the latest publications are on hand or on requisition.

(2) Observe the location of equipment technical manuals and lubrication orders in

the shop. Examine two or three for equipment on hand within the unit; they should show signs of wear and frequent use. A good maintenance shop will have the most commonly required technical publications chained or tied to a board next to the unit's repair benches or shop.

18-9. A Commander's Checklist

a. Do I receive a daily status report as to the operational status of all major equipment in my battery?

b. Are my operators adequately trained, or do they need advanced training? Refresher training?

c. Are my maintenance personnel adequately trained, or do they need additional training?

d. Do I know the status of all PLL requests for inoperative equipment in my unit?

★ e. Do I know how to perform daily inspections on an item of equipment by using the PMCS tables? Do my operators?

f. Have I allotted sufficient time on the battery training schedule for required maintenance operations?

g. Does my unit have a *current* maintenance SOP, and are we operating in accordance with the SOP?

h. Is my PLL current (demand supported), and what is its percentage of fill?

i. Are my motor pool and shop areas adequate? Efficiently organized and used? What unsafe conditions exist? Have I initiated corrective action and followup?

j. Are the tools/tool sets authorized my unit by TOE/MTOE on hand? On order? Serviceable?

k. Have I conducted a command inspection on all my unit equipment recently?

l. Does my parts clerk reconcile outstanding parts requests with my supply source on a routine basis?

m. How long is it taking my personnel to prepare and get a piece of equipment into support shops?

n. Have replenishment requisitions been initiated for repair parts at zero balance?

o. Are repair parts located in accordance with stock record or locator records, and are on-hand balances correct?

p. Do I select one item of equipment each day and spot-check it for correctness or serviceability?

q. Is authorized test equipment on hand? On order? Serviceable? Calibrated?

r. Have I established adequate controls for the safeguard of tools, tool sets, and test equipment?

s. Are my mechanics proficient in the use of the authorized test, measurement, and diagnostic equipment (TMDE), and do they use it?

t. Do I have any problems that MAIT can assist me in solving?

u. Do I have a copy of DA Pamphlet 700-4, *Commander's Maintenance Evaluation Techniques, A Guide for Commanders*, and am I using it?

★ v. Has my pinpoint account been reviewed in the last 6 months, and is a copy of the review on file?



★ APPENDIXES

- A. SELECTED CHARACTERISTICS OF FIELD ARTILLERY CANNONS
- B. GLOSSARY
- C. CANNON SECTION EVALUATION AND TRAINING
- D. GUNNER'S QUALIFICATION TEST
- E. TESTS FOR THE QUALIFICATION OF SAFETY PERSONNEL
- F. MINIMUM QE RAPID FIRE TABLES
- G. COMMON MISTAKES AND MALPRACTICES
- H. INTERNATIONAL STANDARDIZATION AGREEMENTS
- I. INTERCHANGEABILITY OF AMMUNITION
- J. MAINTENANCE AIDS
- ★ K. REFERENCES
- ★ L. FUTURE TRENDS
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★APPENDIX A

SELECTED CHARACTERISTICS OF FIELD ARTILLERY CANNONS

Caliber and model		Maximum range w RAP (meters)	Maximum range w/o RAP (meters)	Tube life in EFC rounds	Type of breechblock	Type of firing mechanism	Type of recoil mechanism	Minimum recoil (max chg, high el)	Maximum recoil (max chg, low el)	Minimum elevation (mils)	Maximum elevation (mils)	Mils per turn of handwheel (elevation)	Type of traverse	Maximum right traverse (mils)	Maximum left traverse (mils)	Mils per turn of handwheel (traverse)	Type of trails	Equilibrators	Panoramic telescope	Telescope mount	Elbow telescope	Range or elevation quadrant	Approximate operating weight (pounds)	Length, traveling	Width, traveling	Height, traveling	Time to emplace (minutes)	Maximum rate of fire (rd/min) (LAW ARTEP)	Sustained rate of fire (rd/min) (first 3 min)	Prime mover	FM	TM	Notes
105-mm howitzer M101A1, towed		NA	M2A1 5,000 M2A2 7,500	HSW	CP M13	HPC	39	42	-89	1,156	10		Pintle	409	400	19	Split	Spring	M12A7S	M21A1	M16A1D	M4A1	4,980	19'8"	7'1 1/2"	5'2"	1	10	3	Hel 2 1/2-ton	6-75	9-1015-203-12	
105-mm howitzer M102, towed		NA	5,000	VSW	SIP	HPV	30	50	-89	1,333	10		Ball and socket	6,400	6,400	21	BG	Spring	M113A1	M134A1	M114A1	M14A1	3,170	22'	6'4"	5'3"	2	10	3	Hel 2 1/2-ton Hel Prcht 5/4-ton		9-1015-234-10	
155-mm howitzer M114A1, towed		19,400 (A2 only)	M1 2,000 M1A1 & M1A1 (Mod)		PH M1	HPV	41	60	0	1,156	15		Pintle	448	418	10	Split	Spring	M12A7Q	M25		M1A1	12,700	24'	8'	5'11"	3 1/2	4	1	5-ton	6-81	9-1025-200-12	
155-mm howitzer M114A2, towed		14,600	7,500	STIS																													
155-mm howitzer M198, towed		30,000	1,750	TIS	CP M35	HPV	50	70	-89	1,279	10		Pintle	400 (6,400 speed)	400	10	Split	Pneu	M137	M171	M138	M17 M18	15,600	39'3"	9'2"	9'6"	TBD	4	*	5-ton		9-1025-211-10	
155-mm howitzer M109, SP		NA	M126 5,000 M126A1 7,500	TIS	CP M35	HPV	24	36	-53	1,333	10		Ring and race	6,400	6,400	10	Veh spade	HP	M117	M146	M118C	M15	23,795 ¹⁹	21'8"	10'4"	10'1"	1 1/2	4	1	SP		9-2350-217-10N	
155-mm howitzer M109A1, A2, A3, SP		23,500											Ring and race				Veh spade	HP															
155-mm howitzer M109A1, A2, A3, SP		18,100	5,000	TIS	CP M35	HPV	24	36	-53	1,333	10		Ring and race	6,400	6,400	10	Veh spade	HP	M117	M146	M118CA1	M15	53,940	29'8"	10'4"	10'1"	1 1/2	4	**1	SP		9-2350-217-10N(A1/A3)	
175-mm gun M107, SP		NA	M113 ***400 M113A1 1,200	STIS	CP M35	HPV	25	70	+35	1,157	2.5		Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M116C	M15	62,100	37'1"	10'4"	11'6"	3	1.5	0.5	SP		9-2300-216-10	
8-inch howitzer M115, towed		NA	7,500	STIS	PH M1	HPV	25	70	-35	1,156	13		Pintle	533	533	10	Split	Pneu	M12A7C	M18A1	M16A1G	M1	29,700	36'	8'3"	9'	20	1.5	0.5	10-ton	6-90	9-3004	
8-inch howitzer M110, SP		NA	7,500	STIS	CP M35	HPV	25	70	+35	1,156	2.5		Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M116	M15	26,535 ¹⁹	24'6"	10'4"	9'9"	2 1/2	1.5	0.5	SP		9-2300-216-10	
8-inch howitzer M110A1, SP		NA	7,500	STIS	CP M35	HPV	25	70	+35	1,156	2.5		Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M139	M15	58,500 62,100	33'11"	10'4"	9'11"	2 1/2	1.5	0.5	SP		9-2300-216-10	
8-inch howitzer M110A2, SP		20,600 30,000	7,500	STIS	CP M35	HPV	25	70	+35	1,156	2.5		Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M139	M15	58,500	33'11"	10'4"	9'11"	2 1/2	1.5	0.5	SP		9-2300-216-10	
8-inch howitzer M110A2, SP		22,900	7,500	STIS	CP M35	HPV	25	70	+35	1,156	2.5		Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M139	M15	62,500	35'3"	10'4"	9'11"	2 1/2	1.5	0.5	SP		9-2350-304-10	

APPENDIX A

SELECTED CHARACTERISTICS OF FIELD ARTILLERY CANNONS

*As indicated by thermal warning device
 **Chg 8: 1 rd/min for 60 min, then 1 rd/3 min thereafter
 ***Maximum of 300 zone 3 rounds
 HSW--Horizontal sliding wedge
 VSW--Vertical sliding wedge
 STIS--Stepped thread, interrupted screw
 TIS--Thread interrupted screw
 PH--Percussion hammer
 CP--Continuous pull
 SIP--Spring actuated, inertia percussion
 HPC--Hydropneumatic constant
 HPV--Hydropneumatic variable
 HP--Hydropneumatic
 Pneu--pneumatic
 BG--Box girder

Caliber and model	Maximum range w/o RAP (meters)	Tube life in EFC rounds	Type of breechblock	Type of firing mechanism	Type of recoil mechanism	Minimum recoil (inches) (max chg, high el)	Maximum recoil (inches) (max chg, low el)	Minimum elevation (mils)	Maximum elevation (mils)	Mils per turn of handwheel (elevation)	Type of traverse	Maximum right traverse (mils)	Maximum left traverse (mils)	Mils per turn of handwheel (traverse)	Type of trails	Equilibrators	Panoramic telescope	Telescope mount	Elbow telescope	Range or elevation quadrant	Approximate operating weight (pounds)	Length, traveling	Width, traveling	Height traveling	Time to emplace (minutes)	Maximum rate of fire (rd/min) (1st 3 min)	Sustained rate of fire (rd/min)	Prime mover	FM	TM	Notes
105-mm howitzer M101A1, towed	11,000	M2A1 5,000 M2A2 7,500	HSW	CP M13	HPC	39	42	-89	1,156	10	Pintle	409	400	19	Split	Spring	M12A7S	M21A1	M16A1D	M4A1	4,980	19'8"	7'1/2"	5'2"	1	10	3	Hel 2 1/2-ton	6-75	9-1015-203-12	
105-mm howitzer M102, towed	11,500	5,000	VSW	SIP	HPV	30	50	-89	1,333	10	Ball and socket	6,400	6,400	21	BG	Spring	M113A1	M134A1	M114A1	M14A1	3,170	22'	6'4"	5'3"	2	10	3	Hel 2 1/2-ton Hel Prcht 5/4-ton		9-1015-234-12	
155-mm howitzer M114A1, towed 155-mm howitzer M114A2, towed	14,600	M1 2,000 M1A1 & M1A1(Mod) 7,500	STIS	PH M1	HPV	41'	60	0	1,156	15	Pintle	448	418	10	Split	Spring	M12A7Q	M25		M1A1	12,700	24'	8'	5'11"	3 1/2	4	1	5-ton	6-81	9-1025-200-12	
155-mm howitzer M198, towed	24,000	TBD	TIS	CP M35	HPV	50	70	-89	1,279	10	Pintle	400 (6400 speed)	400	10	Split	Pneu	M137	M171	M138	M17 M18	15,500	39'3"	9'2"	9'6"	TBD	4	*	5-ton		9-1025-211-10	
155-mm howitzer M109, SP	14,600	M126 5,000 M126A1 7,500	TIS	CP M35	HPV	24	36	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	HP	M117	M146	M118C	M15	52,460	21'8"	10'4"	10'1"	1/2	4	1	SP	6-88	9-2350-217-10N	
155-mm howitzer M109A1, SP	18,100	5,000	TIS	CP M35	HPV	24	36	-53	1,333	10	Ring and race	6,400	6,400	10	Veh spade	HP	M117	M146	M118CA1	M15	53,940	29'8"	10'4"	10'1"	1/2	4	**1	SP	6-88	9-2350-217-10N	
175-mm gun M107, SP	32,800	M113 ***400 M113A1 1200	STIS	CP M35	HPV	25	70	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M116C	M15	62,100	37'1"	10'4"	11'6"	3	1.5	0.5	SP	6-94	9-2300-216-10	
8-inch howitzer M115, towed	16,800	7,500	STIS	PH M1	HPV	25	70	-35	1,156	13	Pintle	533	533	10	Split	Pneu	M12A7C	M18A1	M16A1G	M1	29,700	36'	8'3"	9'	20	1.5	0.5	10-ton	6-90	9-3004	
8-inch howitzer M110, SP	16,800	7,500	STIS	CP M35	HPV	25	70	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M116	M15	58,500	24'6"	10'4"	9'9"	2 1/2	1.5	0.5	SP	6-94	9-2300-216-10	
8-inch howitzer M110A1, SP	20,600	7,500	STIS	CP M35	HPV	25	70	+35	1,156	2.5	Ring and race	533	533	5	Veh spade	Pneu	M115	M137	M139	M15	62,100	33'11"	10'4"	9'11"	2 1/2	1.5	0.5	SP	6-94	9-2300-216-10	

Prcht--Parachute
 2 1/2-ton--Truck
 5-ton--Truck
 5/4-ton--Truck
 10-ton--Truck
 Hel--Helicopter

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★ APPENDIX B

GLOSSARY

B-1. General

In compiling this appendix, every effort has been made to define terms and abbreviations to which the firing battery will be exposed. AR 310-25, *The Dictionary of United States Army Terms*, complements this appendix. All terms and abbreviations are in alphabetical order.

B-2. Definitions

—A—

abatis—Obstacle created by felling trees so that the trunks lie across a road or trail and impede movement.

advance party—A group of unit representatives dispatched to a planned new position in advance of the main body to prepare the position for the arrival of the unit and its equipment.

advanced individual training (AIT)—Training given to enlisted personnel after completion of basic combat training (BCT). AIT teaches the individual specific skills that result in the award of a military occupational specialty (MOS).

advanced noncommissioned officer course (ANCOC)—Course taught at the service school and designed to train selected E6s (skill level 3) to serve in skill level 4 positions. Attendees are selected by Department of the Army on a competitive basis.

aiming circle—An instrument used primarily to measure horizontal and vertical angles and as a laying instrument to place the tube of an indirect fire weapon in a desired direction. The specific uses of the aiming circle are discussed in detail in chapter 8.

aiming point—A sharply defined point or object on which the sight of a weapon is alined when the weapon is laid for direction.

There are two general types of aiming points—*distant* and *close-in*.

aiming posts—Striped rods used, in pairs, as a close-in aiming point.

air droppable—Capable of being parachuted from an aircraft.

air transportable—Capable of being transported by aircraft.

alternate position—The position given to a weapon, unit, or individual to be occupied when the primary position becomes untenable or unsuitable for carrying out its mission. The alternate position is so located that the unit can continue the mission it had in its primary position.

ammunition lot number—Code number that identifies a particular quantity of ammunition from one manufacturer. The number is assigned to each lot of ammunition when it is manufactured.

ammunition supply point (ASP)—Location at which conventional ammunition is available for distribution to using units. It is organized to receive, classify, store, and issue ammunition and is operated by combat service support personnel from the corps. It is located in the corps forward area or the division rear area.

ammunition transfer point (ATP)—Location established in the maneuver brigade trains area to issue high-usage conventional ammunition to using units.

arming range—The range at which fuzes arm.

Army Training and Evaluation Program (ARTEP)—A diagnostic tool used to program training to achieve a specified level of proficiency and to evaluate performance. Each ARTEP provides training and evaluation outlines that contain minimum collective training performance objectives (task, condition, standard) for specific missions and levels of training.

Additionally, it contains guidance on how the ARTEP can be used for training evaluations.

assault fire—Extremely accurate, short-range fires at point targets, such as bunkers or fortifications, using indirect laying.

axis of tube—Imaginary center line of the tube of a cannon.

azimuth—A horizontal, *clockwise* angle measured from north. This angle may be a —

grid azimuth, measured from grid north. This is the azimuth normally employed in the field artillery. Normally, the command given to indicate the grid azimuth of the direction of fire is AZIMUTH (so much).

magnetic azimuth, measured from magnetic north; a

true azimuth, measured from true north; or a

azimuth of fire—The direction, expressed in mils, that a battery lays on when it occupies a position.

—B—

back-azimuth—The back-azimuth is equal to the azimuth plus or minus 3200 mils. If the azimuth of line AB is 500 mils, then its back-azimuth is 3700 mils ($500 + 3200$). If the azimuth of line CP is 5300 mils, the back-azimuth is 2100 mils ($5300 - 3200$).

base-ejection shell—A type of projectile that ejects its load from the base. An example is the M449 155-mm ICM projectile.

base piece—The weapon whose shooting strength is closest to the average shooting strength of the battery. It is located on the battery center and normally is used for registration.

basic combat training (BCT)—Training in basic military subjects and the fundamentals of soldiering given to newly enlisted Active Army and Reserve Component personnel without prior military service.

basic issue items (BII)—Crew/operator maintenance accessories and tools that are initially issued with a particular end/component item. Range and quantity of BII are designated in the basic issue items list within the applicable operator's manual.

basic load of ammunition—The amount of ammunition a unit is authorized to maintain to initiate combat and sustain itself until resupplied.

basic noncommissioned officer course (BNCOC)—Course designed to teach the junior combat arms NCO to be a section chief, progressing from skill level 2 to skill level 3. The student acquires additional technical expertise in his MOS and receives instruction on how to train and lead his section to successful performance of ARTEP missions. Taught at installation/division level.

battery center—The point over which the base piece is located. It is the chart location of the battery and should be near the geographic center of all the weapons.

battery front—Lateral distance between the flank cannons of a battery.

battery operations center (BOC)—A facility established to serve as an alternate FDC and as the battery CP.

boresighting—The process by which the optical axes of the weapon sights are aligned parallel to the axis of the cannon tube. The primary methods of boresighting are with the alinement device, a distant aiming point, or the testing target. Emergency methods are discussed in chapter 12.

—C—

caliber—1. The diameter of the bore of a weapon, obtained in rifled weapons by measuring between opposite lands. 2. Diameter of a projectile. 3. Unit of measure used to express the length of the bore of a weapon. The number of calibers is determined by dividing the length of the bore of the weapon, from breech face of the tube to the muzzle, by the diameter of its bore.

CANCEL—A command which, when coupled with an order, rescinds that order. For example, CANCEL CHECK FIRING indicates the previous order to check firing is no longer in effect.

CEASE LOADING—A command given to cause a halt in firing, allowing weapons to fire loaded ammunition but none thereafter.

centralized training—Training that is controlled, programed, and scheduled by a headquarters above the unit normally responsible for conducting the training.

charge—The propellant of semifixed or separate-loading ammunition.

CHECK FIRING—A command given to cause an immediate halt in firing.

close-in aiming point—The primary close-in aiming point is the infinity collimator, a lightweight optical instrument that simulates an aiming point at infinity. The collimator should be emplaced 4 to 15 meters to the left front of the weapon. A secondary close-in aiming point is a set of two aiming posts. If possible, the far aiming post should be placed 100 meters from the weapon. In any case, the near post must be placed half the distance to the far post. When alined, the two posts establish a line along which the panoramic telescope is sighted when laying for direction.

collective training—That training which prepares soldiers to perform those team or unit tasks essential to the accomplishment of a unit's TOE and/or operational mission.

collimator—An infinity reference device used as a close-in aiming point during indirect fire.

command post exercise (CPX)—A tactical exercise that includes only the command and communications personnel of a unit. For the cannon battery, this includes the FDC, the BOC, and appropriate FIST personnel. The purpose of the CPX is to exercise and train these personnel without committing the entire unit.

commander's manual—A manual that lists for the training manager all the critical tasks, by skill level, that every soldier of a given MOS must master. Designed for all officers/senior NCOs having soldiers of the particular MOS under their command supervision, it also lists study materials and references applicable to each task as well as the source and location of task training.

common deflection—The deflection corresponding to the initial azimuth of lay

that the FDC has plotted on its firing charts. The common deflection for all weapons with M100-series sights is 3200. For the M101A1 it is 2800, and for the M114A1 (A2) it is 2400.

complete round—Term that defines the various components required to perform the firing function. In field artillery weapons, there are two types of complete rounds of ammunition: 1. Separate-loading, consisting of a primer, propelling charge, projectile, and fuze. 2. Fixed or semifixed, consisting of a primer, propelling charge, cartridge case, projectile, and fuze.

conditions—A statement that specifies the circumstances under which a particular task is to be performed; e.g., information/equipment provided or denied a soldier for the performance of a task.

continuous fire—Fires delivered by loading and firing as rapidly as possible consistent with accuracy and within the prescribed rates of fire for the pieces.

converged sheaf—A sheaf in which the planes of fire meet at a designated point.

cookoff—Functioning of chambered ammunition caused by the heat of the weapon rather than by normal firing.

coppering—Metal fouling left in the bore of a cannon by the rotating band of a projectile.

counterfire—Fires directed against indirect fire systems, to include their weapons, command and control, communications, ammunition, and target acquisition components.

counterrecoil—Forward motion of a cannon returning to firing (in-battery) position after recoil.

crater analysis—Process by which the direction to an artillery or mortar unit is determined from analysis of the shell crater. Additionally, shell fragments are collected to determine the type of shell that caused the crater.

crest—A terrain feature of such altitude that it limits the minimum elevation of a weapon.

crew-served weapons—Weapons, such as machineguns or howitzers, that require two or more persons to operate.

—D—

danger close—Field artillery fires delivered within 600 meters of friendly forces.

decentralized training—Releases the authority and responsibility for the detailed planning, conduct, and internal evaluation of training to the battalion or separate company level. Brigade headquarters and above retain the responsibility for providing mission-type guidance to their subordinate units, allocating training resources, coordination, and the broad supervision/evaluation of training.

declination constant—The horizontal clockwise angle from grid north to magnetic north; in other words, it is the grid azimuth of magnetic north. Usually, the declination constant is recorded for every instrument equipped with a magnetic needle. The constant for any instrument will vary in different localities, and the constant of different instruments in the same locality also will vary. This variation is due to slight differences in manufacturing and to the shock from handling of the instruments during normal use.

dedicated battery—A cannon battery whose total firepower is immediately available to suppress enemy direct fire weapons that threaten a designated maneuver company/team. For additional information, see FM 6-20 and FM 6-40-5.

deflection (DF)—The horizontal, clockwise angle from the line of fire—or the rearward extension of the line of fire—to the line of sight to a designated aiming point. The vertex of the angle is at the sight. If the pieces are equipped with the M12-series panoramic telescopes, deflection never exceeds 3,200 mils. In addition to deflection as a fire command, the firing battery is concerned with both *common* and *referred* deflection.

deflection board—A device used with field artillery weapons equipped with the 12-series panoramic telescope to measure the small deflection changes necessary in assault fire.

destruction fire—Indirect fire delivered with the sole purpose of destroying materiel targets.

direct fire—Fire in which the target itself is used as the aiming point, utilizing direct laying techniques.

direct laying—The aiming of a piece by sighting directly on the target.

direct support maintenance—Maintenance that is authorized and performed by designated maintenance activities in direct support of using organizations. This category of maintenance is limited to repair of end items or unserviceable assemblies in support of using organizations on a return-to-user basis.

displacement—1. The act of leaving a position preparatory to occupying another.
2. The undesired movement of a weapon caused by traversing or firing.

distant aiming point (DAP)—A point at least 1500 meters from the pieces so that normal displacement in firing or traverse will not cause a horizontal angular change in direction (with the same setting on the azimuth scales) of more than one-half mil. An advantage of using a distant aiming point is that it may be used immediately upon occupation of a position. Some disadvantages of using a distant aiming point are that it may be obscured by darkness, dust, fog, or smoke; illumination is not practicable; and the pieces are not *exactly* parallel when laid on a common deflection.

distribution of fire—The pattern of bursts in the target area. Normally, all pieces of a battery fire with the same deflection and the same quadrant elevation. It is sometimes necessary to adjust the pattern of bursts to the shape and size of the target. Also, there are times when the battery must occupy terrain positions without regard to the spacing between howitzers. In these cases, individual piece corrections for deflection, fuze setting, and quadrant elevation are computed and applied to obtain a specific pattern of bursts. In some cases, a rapid computation and application of a deflection difference is made to make the distance between flank bursts approximately equal to the width of the target. See *terrain gun position corrections*.

dud—An explosive munition which has failed to explode after being armed, thus creating a potentially hazardous condition.

—E—

end of the orienting line (EOL)—A point on the orienting line (OL) marked by any sharply defined permanent or semi-permanent object such as a steeple, flagpole, or stake. If possible, it should be visible during darkness.

equipment serviceability criteria (ESC)—Tests and measurements prescribed for mission-essential, maintenance-significant equipment to evaluate its capability to satisfactorily perform its primary mission for a period of 90 days with normal maintenance support.

equivalent full charge (EFC)—The method used to determine the remaining life of a cannon tube. To convert to EFC rounds, the quantity of rounds fired is multiplied by the EFC factor as indicated in the weapon TM. Computations are recorded on DA Form 2408-4.

evaluation of training—The processes that by objective and subjective means, are used to determine the extent of the learning progress of individuals and units. The purpose is to determine if a training objective has been attained. Evaluation provides the training manager with the information he needs to modify or update his training program and provides feedback to trainers on the effectiveness of their training.

—F—

field storage location (FSL)—A controlled, limited-access area in which a unit having custody of nuclear weapons stores them. Its primary purpose is to prevent unauthorized and uncontrolled access to the weapons.

financial training resources—Funds allocated to conduct training activities, to purchase training aids/devices, and/or to purchase other materials to be used for training. School TDY funds and adventure training funds are examples.

fire control alinement tests—Tests performed to determine if the fire control equipment on a howitzer or gun is correctly alined. Certain adjustments of misalined equipment can be made by the crew or the artillery mechanic; whereas, other adjustments must be made by higher categories of maintenance. Formerly referred to as basic periodic tests.

fire support team (FIST)—In fire support operations, a team comprising of a team chief (FA lieutenant) and the necessary additional personnel and equipment required to request, coordinate, and direct fire support efforts for company-size units.

forcing cone—Tapered beginning of the lands of the rifling of a cannon tube. The forcing cone allows the rotating band of the projectile to be gradually engaged by the rifling, thereby centering the projectile in the bore.

—G—

grid declination—The smaller angle between true north and grid north. Grid declination is indicated in the marginal data of maps as east or west of true north.

grid north—The north direction of the vertical grid lines on a military map, a photomap, or a grid sheet. Since determination of firing data for direction is based on grid north, the term "azimuth" normally means grid azimuth.

gun—A field artillery weapon characterized by a relatively long barrel, high muzzle velocity, and flat trajectory.

—H—

hangfire—Temporary failure or delay in the action of a primer, an igniter, or a propelling charge.

hasty survey—Techniques used to establish rapid and sufficiently accurate direction and/or position data through simplified procedures and with cannon battery TOE equipment. See chapter 9 for detailed procedures.

hip shoot (emergency fire mission)—Occupation of a position from a convoy without prior reconnaissance and firing from this position.

hot platoon—A cannon platoon designated to maintain full crews at their posts for instant reaction to a fire mission. This technique minimizes reaction time to calls for fire and allows the other platoon(s) to accomplish the various tasks that must be performed during position improvement.

howitzer—A field artillery weapon characterized by a medium length barrel (between that of a mortar and a gun), a relatively high angle of fire, and a medium muzzle velocity.

human resources—All personnel who participate in training. It includes those who assist the commander in the planning, conduct, and evaluation of training and those individuals who receive the training.

—I—

immediate actions—Actions taken or duties performed in instantaneous response to enemy attack, particularly by artillery (counterfire).

immediate suppression—Field artillery fires required when the enemy has fired from, or has been seen and can fire from, a given location such that direct fire weapons and supporting field artillery must respond instantaneously.

indirect laying—The aiming of a piece by sighting at an aiming point other than the target. The piece is laid for direction by setting a given deflection on the sight and

traversing the tube until the line of sight of the panoramic telescope is on the aiming point. The piece is laid for elevation on the range quadrant or gunner's quadrant by elevating or depressing the tube until the appropriate bubble is centered.

individual training—The training received by an individual without regard to grade or level of proficiency. Individual training begins when the individual enters the Army and continues throughout his service. Initially, emphasis is placed on development of the individual as a basic soldier. Emphasis is then shifted to the development of the primary skills necessary to perform in a specific MOS at varying skill levels.

institutional training—Training, both individual and collective, that is conducted in schools (Army service school, USAR school, unit school) or army training centers (ATC).

—J—

jamming—The intentional transmission of interfering electronic signals in order to disrupt the reception of other signals.

job book—A pocket-size booklet designed to serve as an informal record of the soldier's proficiency in the tasks required of his present duty position. It is issued to the soldier and NCO supervisor. The pencil entries—made on a "GO" or "NO GO" basis for soldier's manual tasks—serve as a valuable section-level training management tool. It is *not* to be inspected.

—L—

laid—A weapon is laid when the axis of the tube is accurately aimed in a predetermined direction.

lands—Raised portion between grooves in the bore of a cannon tube. Spiral channels cut in the bore of the cannon tube are the grooves.

line of fire—The direction of the line established by the tube or any line parallel to that line in the firing battery. It is an imaginary line extending through the central axis of the tube when looking through the

breech to the muzzle of the weapon. The rearward extension of the line of fire is a line in the exact opposite direction of the line of fire.

—M—

magnetic declination—The smaller angle between true north and magnetic north. This angle is indicated in the marginal data of maps as east or west of true north. Since the magnetic declination varies slightly from year to year, a correction factor—the *annual magnetic change*—is also shown in the marginal data of military maps.

magnetic north—The direction to the magnetic North Pole.

mil—A unit of measurement for angles based on the angle subtended by 1/6400 of the circumference of a circle.

minimum quadrant elevation (MIN QE)—The lowest quadrant elevation of a weapon at which the projectile will safely clear an obstacle between the weapon and the target. This applies to crests visible from the battery position and to intermediate crests along the trajectory.

misfire—The failure of a round to fire after initiating action is taken. The failure may be due to a faulty firing (percussion) mechanism or a faulty ammunition component.

mission-related training—Individual or collective training that contributes directly to the accomplishment of the unit mission. It includes a wide variety of activities and excludes such diversionary activities as special duty, administrative appointments, general educational classes, honor guards, fatigue details, and routine medical care.

muzzle velocity—The velocity of a projectile at the instant it leaves the muzzle of a weapon.

—O—

one-station unit training (OSUT)—Training given to initial entry level trainees for high density MOSs that totally integrates BCT and AIT. OSUT trains the individual in basic soldier skills and in skill level 1 tasks that result in the award of the MOS.

on-the-job training (OJT)—A training process whereby students or trainees acquire knowledges and skills through actual performance of duties under competent supervision, in accordance with an approved, planned program.

open sheaf—A sheaf in which the lateral distance between adjacent bursts equals the maximum effective width of burst.

operator/crew maintenance—Includes the proper care, use, and operation of equipment by the operator or crew. It consists of performing before-, during-, and after-operation maintenance; reporting malfunctions that they are not authorized to correct; and making proper entries on equipment records as required by TM 38-750.

organizational maintenance—Maintenance that is the responsibility of, and performed by, a using organization on its assigned equipment. It includes both battery and battalion levels.

orienting angle (OA)—A horizontal, clockwise angle from the line of fire to the orienting line.

orienting line (OL)—A line of known direction, materialized on the ground near the firing battery, that serves as a basis for laying the battery for direction. The azimuth of the orienting line is the direction from the orienting station to a designated end of the orienting line (EOL).

orienting station (OS)—A point established on the orienting line. The aiming circle is set up over this point to lay the pieces by the orienting angle method.

—P—

panoramic telescope (usually called the *sight* or *pantel*)—A fire control instrument used for either direct or indirect fire. When the panoramic telescope is used in its most common role, indirect fire, it allows the operator to apply a specified change in the direction (deflection) to the tube of the piece by changing the line of sight of the telescope the same amount and then traversing back to the fixed point. Panoramic telescopes used on current field artillery weapons are as follows:

Weapon	Series	Common	
		Max DF	DF
M101A1	M12	3200	2800
M114A1(A2)	M12	3200	2400
M102	M100	6400	3200
M109/M109A1	M100	6400	3200
M110/M110A1	M100	6400	3200
M107	M100	6400	3200

parallel (normal) sheaf—A sheaf in which the planes of fire of all pieces are parallel. Regardless of the range, the bursts will be spaced laterally at the same intervals as the pieces.

performance objective—A statement that specifies an individual or team/unit task, the condition(s) under which the task is accomplished, and the training standard required to demonstrate minimum acceptable proficiency.

performance-oriented training and testing—A training and testing technique through which individuals or crews/units perform one or more tasks, under specified conditions, to demonstrate a level of proficiency matching an expressed standard.

preventive maintenance (PM)—Care and servicing to maintain equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of failures either before they occur or before they develop into major defects.

preventive maintenance indicators (PMI)—Areas of possible failure or malfunction in equipment that can be

detected by localized application of the sense of sight, sound, touch, or smell to indicate the condition and quality of maintenance.

primary noncommissioned officer course (PNCOC)—A course designed for the combat arms soldier in grade E4 who has been selected by his commander as having NCO potential. Taught at installation/division level, it includes the leadership and training skills needed for advancement to skill level 2.

primary position—The position from which a battery intends to perform its assigned mission.

prime time for training—An established period of time (hours, days, or weeks) devoted entirely to mission-related training. It should be established at the lowest level possible with the maximum number of personnel present for training. Administrative absences should be limited to non-prime time periods, to increase training effectiveness.

priority target—A target designated as critical by a maneuver commander on the basis of type, location, or time sensitivity. A priority target is one that firing units lay on while not engaged in a fire mission. Generally, one battery will be laid on each priority target (as with an FPF). However, in dedicated battery operations, a platoon normally lays on a planned priority target.

—Q—

"Q" service—A scheduled maintenance service, usually associated with tracked vehicles, that normally is performed every 750 miles of operation.

—R—

recoil—Rearward motion of a weapon caused by firing.

refer—To measure (using the panoramic telescope) the deflection to a given aiming point without moving the tube. In some instances, this *referred deflection* will be reported. If it is desired that it be recorded, the command RECORD REFERRED DEFLECTION is announced.

referred deflection—(See *refer*).

REPEAT—An order to fire again the same number of rounds, with the same method of fire and firing data.

—S—

scheduled maintenance service—A periodic prescribed inspection and servicing of equipment accomplished on a calendar, mileage, or hours-of-operation basis.

self-study—Individual study by which the soldier learns new skills, acquires new knowledges, or reinforces those already learned.

sheaf—The lateral distribution of the bursts of two or more pieces fired together. The width of the sheaf is the lateral distance (perpendicular to the direction of fire) between the centers of flank bursts. The front covered by any sheaf is the width of the sheaf plus the effective width of one burst. A sheaf may be formed in any of the following patterns: *converged, open, parallel (normal), or special*.

skill level (SL)—The level of proficiency within a given MOS, indicated by the fourth digit of the MOS code. A howitzer section chief (E6), MOS 13B30, is at skill level 3.

skill qualification test (SQT)—A test designed to determine if the soldier is qualified in his present skill level and if he is eligible for advancement to the next higher skill level. It consists of three components: written exercises, hands-on performance, and commander's certification.

small unit transceiver (SUT)—A short-range FM radio designed to supplement the intrabattery wire system and to enhance command and control of marches and movements. Basis of issue will be one per cannon section, FDC, and BOC.

soldier's manual—An MOS training guide (FM) that contains those critical tasks in which a soldier must be qualified to be proficient in his MOS and to advance to the next higher MOS skill level. Each soldier is responsible for retaining and maintaining his own manual.

special sheaf—Any sheaf other than those previously defined.

"S" service—A scheduled maintenance service, usually associated with wheeled vehicles, that normally is performed every 6,000 miles of operation or every 6 months, whichever comes first.

supplementary position—A position selected for accomplishment of a specific mission.

suppressive fires—Fires, direct and indirect, brought to bear on known or likely enemy locations to degrade the enemy's ability to place effective fire on friendly maneuver elements.

—T—

tactical exercise without troops (TEWT)—A training exercise in which a unit's leaders plan and discuss the movement and disposition of simulated troops or equipment at a given location. Its focus is the discussion and learning of tactical principles in a tactical setting.

task—A statement that specifies an action to be performed by an individual or team/unit.

terrain gun position corrections (TGPC)—Precomputed corrections carried at the firing battery to compensate for terrain positioning and muzzle velocity differences.

terrain march—An off-road movement used to reduce vulnerability and to avoid traffic congestion, particularly when enemy observation, interdiction by artillery, or air attack is likely. A unit or an element of a unit using this technique travels along gullies and close to treelines and hill masses.

trainers—Personnel whose duties include the requirement to prepare, conduct, and evaluate training (e.g., a howitzer section chief who prepares, conducts, and evaluates howitzer crew training).

training calendar—A visual aid depicting a schedule of principal training activities for a given period of time. It is used as a management tool to facilitate the planning and programming of major training activities (e.g., FTXs and range firing).

training extension course (TEC)—A multimedia approach to individual and small group training. TEC lessons can be audiovisual, audio only, or programed text.

training goal—A broad statement of desired individual or unit proficiency with respect to a capability required for mission/readiness accomplishment.

training management—The art of employing resources (human, physical, financial, and time) in a manner that permits efficient and effective development of individuals and units to successfully accomplish peacetime and combat missions.

training managers—Individuals who are responsible for the planning, organization, conduct, and evaluation of training. Training managers include the commanders who develop a training program or who provide guidance to other commanders.

training program—A program that outlines the general plan for the conduct of training for the entire organization for specified periods of time. They are prepared and disseminated for the information of all personnel concerned with training.

training resources—Those resources (human, physical, financial, and time) used to conduct or support training. They may be internally controlled by a unit or externally controlled by other headquarters, who allocate their use to units as required.

training standard—A statement that specifies the minimum acceptable proficiency required of an individual or team/unit in the performance of a particular task under stated conditions.

true north—The direction to the geographic North Pole.

—U—

unit training—Training, either individual or collective, conducted in a unit.

B-3. Abbreviations and Acronyms

A

AAP	Allied Administrative Publication
ABCA-	American, British, Canadian, Australian
AC-	aiming circle
ADAM-	area denial artillery munition
ADFT-	artillery direct fire trainer
adj-	adjust
AF-	adjust fire
AIT-	advanced individual training
alt-	altitude
AMC-	at my command
ANCOC-	advanced noncommissioned officer course
AP-	antipersonnel
APC-	armored personnel carrier
ARMCOM-	United States Army Armament Command
ARTEP-	Army Training and Evaluation Program
ASP-	ammunition supply point
ASR-	ammunition supply rate
ATGM-	antitank guided missile
ATP-	ammunition transfer point
AXO-	assistant executive officer
az-	azimuth

B

BC-	battery commander
BCS-	battery computer system
BCT-	basic combat training
BDU-	battery display unit (TACFIRE)
BII-	basic issue items
bn-	battalion
BNCOC-	basic noncommissioned officer course
BOC-	battery operations center
BP-	base piece, battery piece
btry-	battery

C

cal-	caliber
CAS-	comp site (complementary angle of site)

CEP- circular error probable
 CEOI- communications-electronics
 operating instructions
 CENTO- Central Treaty Organization
 CF- command fire
 CFB- chief of firing battery
 CFF- call for fire
 chg- charge
 CLGP- cannon-launched guided
 projectile
 CM- commander's manual
 COMSEC- communications security
 corr- correction
 CP- concrete piercing (fuze)/
 checkpoint
 CPX- command post exercise
 CS- complementary angle of site
 CSMO- close station march order
 CTA- common table of allowances

D

DAP- distant aiming point
 DC- declination constant
 decl- declination
 df- deflection
 dir- direction
 dis- distance
 DMD- digital message device
 (TACFIRE)
 DP- dual purpose
 DPICM- dual purpose improved
 conventional munitions
 DS- direct support

E

ECM- electronic countermeasures
 ED- emergency destruction
 EFC- equivalent full charge
 el, elev- elevation
 EOL- end of orienting line
 EOM- end of mission
 ESC- equipment serviceability
 criteria
 EW- electronic warfare

F

FA- field artillery

FAASV- field artillery ammunition
 supply vehicle
 FADAC- field artillery digital
 automatic computer
 FASCAM- family of scatterable mines
 FD- fire direction
 FDC- fire direction center
 FDO- fire direction officer
 FEBA- forward edge of the battle area
 FFE- fire for effect
 FIST- fire support team
 FM- frequency modulated/field
 manual
 FO- forward observer
 FPF- final protective fire
 FS- fuze setting
 FSCoord- fire support coordinator
 FSL- field storage location
 FSO- fire support officer
 FTX- field training exercise
 fz- fuze

G

GA- gun assembly (BCS)
 GB- green bag
 GDU- gun display unit (BCS)
 GFT/TFT- graphical firing table/
 tabular firing table
 GS- general support
 GSR- general support reinforcing
 GST- graphical site table
 GT- gun-target

H

HA- high angle
 HE- high explosive
 HEDP- high explosive dual purpose
 round (40-mm)
 HEP- high explosive plastic round
 (105-mm)
 HES- high explosive spotting
 HOB- height of burst
 HUMINT- human intelligence

I

IAW- in accordance with

ICM- improved conventional munitions
ill- illumination
inc- increase
IR- infrared

K

KJ- killer junior
KZ- kill zone

L

L- left
LARS- left, add; right, subtract
LAW- light antitank weapon
LITR- low-cost indirect fire training round
LO- lubrication order
LP- listening post
LWSS- lightweight screening system

M

m- meter
m- mil
MAIT- military assistance and instruction team
MAR- minimum arming range
MG- machinegun
min QE- minimum quadrant elevation
m/s- meters per second
MT- mechanical time (fuze)
MTOE- mobilization tables of organization and equipment
MTSQ- mechanical time superquick (fuze)
MV- muzzle velocity
MWO- modification work order

N

NATO- North Atlantic Treaty Organization
NBC- nuclear, biological, chemical
NCO- noncommissioned officer
NCS- net control station
NSN- national stock number
nuc- nuclear

O

OA- orienting angle
OIC- officer-in-charge
OJT- on-the-job training
OL- orienting line
OP- observation post
OPSEC- operations security
OS- orienting station
OSUT- one-station unit training

P

pantel- panoramic telescope
PC- piece-to-crest
PCR- piece-to-crest range
PD- point detonating (fuze)
PHOTINT- photographic intelligence
PLL- prescribed load list
PM- preventive maintenance
PMCS- preventive maintenance checks and services
PMI- preventive maintenance indicators
PNCOC- primary noncommissioned officer course
PNL- prescribed nuclear load
pos- position
prec reg- precision registration
proj- projectile
prop- propellant
PT- propellant temperature

Q

Q- quick (fuze)
QE- quadrant elevation
QSAL- Quadripartite Standardization Agreement List
QSTAG- Quadripartite Standardization Agreement

R

R- right or reinforcing
RAAM- remotely activated antitank mine
RAP- rocket-assisted projectile
RATELO- radiotelephone operator
RCO- range control officer

RDP- range-deflection protractor
 reg pt- registration point
 rg- range
 RP- release point
 RSOP- reconnaissance, selection,
 and occupation of position

S

S- south
 SCA- section chief's assembly
 (BCS)
 si- site
 SIGINT- signal intelligence
 SITREP- situation report
 SL- skill level
 SM- soldier's manual
 smk- smoke
 SOP- standing operating procedure
 SP- self-propelled/start point
 SQT- skill qualification test
 STANAG- Standardization Agreement
 STE/ICE- simplified test equipment for
 internal combustion engines
 SUT- small-unit transceiver
 SW- southwest

T

TACFIRE- tactical fire direction system
 TASC- Training Aids Services
 Center
 TAMMS- The Army Maintenance
 Management System
 TB- technical bulletin

TC- training circular
 TEC- training extension course
 TEWT- tactical exercise without
 troops
 TGPC- terrain gun position
 correction
 ti- time
 TM- technical manual
 TOC- tactical operations center
 TOE- tables of organization and
 equipment
 TOF- time of flight
 TOT- time on target, total
 TM- technical manual
 TWD- thermal warning device

U

USAFAS- US Army Field Artillery
 School

V

VE- velocity error
 VFMED- variable format entry device
 (TACFIRE)
 VT- variable time (fuze)

W

W- west, width
 WB- white bag
 WP- white phosphorus
 wt- weight

X

XO- executive officer
 XO's
 min QE- executive officer's minimum
 quadrant elevation



APPENDIX C

CANNON SECTION EVALUATION AND TRAINING

Section I. GENERAL

C-1. Scope

This appendix is an evaluation and training guide for the howitzer sections of a cannon firing battery. It is universal in scope and can be adapted readily to all cannon weapon systems currently in the Army inventory. It is a performance-oriented evaluation designed to extend and amplify the performance objectives for a howitzer section contained in the current ARTEPs. It may be administered—

Formally or informally.

With a minimum of administrative support.

In the local training area.

In a nonfiring but tactical environment.

C-2. Purpose

a. The evaluation is a performance test of the skills that are essential to the successful accomplishment of the mission of the individual cannon section. Although many of the tasks are evaluated on the basis of individual performance, the evaluation will in fact measure the ability of the section to function as a team. The tasks in the evaluation include training objectives in the ARTEP for the individual cannon sections as well as some of the general training objectives that apply to all sections in the battery. The latter are evaluated by means of the written test portion.

b. The evaluation can be used by the commander—

To evaluate the current state of training proficiency of the section.

As a competitive evaluation to determine the best section within a unit.

As a basis for a howitzer/gun crew training program in preparation for a formal battery or battalion training evaluation based on the ARTEP.

To serve as a supplement to performance-oriented training. The tasks laid out in this appendix should be used as training vehicles, with as much time as possible devoted to *controlled practice of a task*. The sections should practice each task to acquire the degree of proficiency required by the standards set forth in the evaluation.

C-3. Conduct of the Evaluation

This evaluation consists of five phases. It evaluates the ability of the section chief to organize and train his personnel into a cohesive, effective fighting unit.

Phase I—An orientation and organization period, beginning with a statement of the purpose, scope, and the description of the evaluation. During phase I, a written test on general military knowledge will be administered. This phase should be conducted in a classroom on a day prior to the test.

Phase II—Preparation in an assembly area for movement to a location for a deliberate occupation and subsequent firing operations.

Phase III—The deliberate occupation of a prepared position.

Phase IV—Conduct of various types of fire missions.

Phase V—A critique of the performance of individual sections.

Phases II through IV of the evaluation are constructed around a tactical scenario that can be altered to fit the training area and the time available (training resources).

C-4. Evaluation Format

a. The *task* is a general statement of the requirement for the particular evaluation.

b. The *conditions* outline the specific environment or situation in which the

evaluation will be administered. They state what assistance or reference materials, if any, are authorized and what equipment or personnel are required for proper evaluation administration.

c. Evaluation checklists are the requirements for successful completion of that particular task. Specific technical procedures required in the task will be evaluated by the examiner on the basis of the established procedures in the appropriate reference.

C-5. Scoring

The performance evaluation will be administered within a time framework on a **go/no go** basis; the examinee either passes or fails. The examiner will base his judgment upon the criteria stated in the evaluation checklist and upon the most current reference for that particular task.

C-6. Preparation

All necessary preparations, as indicated in the conditions for each task, will be made prior to the beginning of that task. The examiner will insure that the examinee understands the task to be performed.

C-7. Qualification

a. If the evaluation is administered solely for the purpose of determining the state of training of individual sections within a unit, no formal score is required. The commander can readily determine the strengths and weaknesses of his sections simply by subjectively analyzing the **go** or **no go** ratings received for each task performed.

b. The evaluation *may* be used to determine the best section in a unit by determining a formal score. To determine the score for individual sections, add the numerical score attained in each of the four scored phases. The following qualification scheme is suggested for formal evaluation:

DISTINGUISHED	OUTSTANDING	EXCELLENT	SATISFACTORY	UNQUALIFIED
951-1000	900-950	800-899	700-799	0-699

Appropriate awards, such as distinctive patches, certificates, and passes, can be given to recognize outstanding and distinguished sections.

Section II. ORGANIZATION AND SCORING

The five phases are organized and scored as follows:

Phase	Task	Points Task	Possible Phase
I	ORIENTATION/ORGANIZATION		
	Task 1: Written test.	50	50
II	PREPARATION FOR FIRING OPERATIONS		
	Task 2: Preparation for deliberate occupation of a prepared position.	72	
	Task 3: Disassembly of breech mechanism.	49	
	Task 4: Assembly of breech mechanism.	49	
	Task 5: Performance of micrometer test on the gunner's quadrant.	40	
	Task 6: Performance of the end-for-end test.	40	250
III	DELIBERATE OCCUPATION		
	Task 7: Preparation of position by gun guide.	60	
	Task 8: Emplacing the cannon.	60	
	Task 9: Laying the cannon for direction.	56	
	Task 10: Establishing aiming points.	50	
	Task 11: Performing prefire checks.	70	
	Task 12: Position improvement.	54	350
IV	FIRE MISSIONS		
	Task 13: Conduct of indirect fire missions.	120	
	Task 14: Preparation of nonnuclear ammo for firing.	100	
	Task 15: Planned priority targets.	42	
	Task 16: Conduct of direct fire.	88	350
V	CRITIQUE	NA	NA
	TOTAL		1000

Note: This scoring breakdown is a suggested means of evaluating competing sections on a graded basis. Units may alter this scheme to fit their particular situations or training needs and priorities.

Recommended Grading Sheet

Cannon Section Evaluation

UNIT _____ SECTION _____ DATE _____

Section Chief _____	No 3 Cannoneer _____
Gunner _____	No 4 Cannoneer _____
Asst Gunner _____	No 5 Cannoneer _____
No 1 Cannoneer _____	Driver _____
No 2 Cannoneer _____	M548 Driver _____

Phase I—Orientation/Organization

TASK 1: Written test.

1. Section member scores:

Gunner	_____ /25 correct
Assistant gunner	_____ /25 correct
No. 1	_____ /25 correct
No. 2	_____ /25 correct
No. 3	_____ /25 correct
No. 4	_____ /25 correct
No. 5	_____ /25 correct
(Add other personnel as required)	
Driver	_____ /25 correct
M548 driver	_____ /25 correct
 2. Section average = _____ /25 correct
 3. Section average _____ $\times 2 =$ _____ points (maximum 50)
- Total PHASE I _____ points (max 50)

Phase II—Preparation for Firing Operations

TASK 2: Preparation for deliberate occupation.

Maximum points 72 minus _____ no go's $\times 8$ points = _____ points

TASK 3: Disassembly of breech mechanism.

1. Any no go's awarded? Yes = 0 points
2. If all go's awarded: Time = _____ = _____ points (max 49)

TASK 4: Assembly of breech mechanism.

1. Any no go's awarded? Yes = 0 points
2. If all go's awarded: Time = _____ = _____ points (max 49)

TASK 5: Micrometer test on gunner's quadrant.

1. Any no go's awarded? Yes = 0 points
2. If all go's awarded: Time = _____ = _____ points (max 40)

TASK 6: Performance of the end-for-end test.

1. Any no go's awarded? Yes = 0 points
 2. If all go's awarded: Time = _____ = _____ points (max 40)
- Total PHASE II _____ points (max 250)

Phase III—Deliberate Occupation**TASK 7: Preparation of position by gun guide.**

_____ go ratings x 6 = _____ points (max 60)

TASK 8: Emplacing the cannon.

_____ go ratings x 12 = _____ points (max 60)

TASK 9: Laying the cannon for direction.

_____ go ratings x 7 = _____ points (max 56)

TASK 10: Establishing aiming points.

_____ go ratings x 10 = _____ points (max 50)

TASK 11: Performing prefire checks.

_____ go ratings x 7 = _____ points (max 70)

TASK 12: Position improvement.

_____ go ratings x 9 = _____ points (max 54)

Total PHASE III _____ points (max 350)

Phase IV—Fire Missions

TASK 13: Conduct of indirect fire missions.

120 possible points minus _____ = _____ points.

TASK 14: Preparation of nonnuclear ammo for firing.

_____ go ratings x 5 = _____ points (max 100)

TASK 15: Planned priority targets.

_____ go ratings x 6 = _____ points (max 42)

TASK 16: Conduct of direct fire.

88 possible points minus _____ = _____ points.

Total PHASE IV _____ points (max 350)

OVERALL TOTAL _____ points (max 1000)

Phase V—Critique

Section III. EVALUATION PHASE I

During this phase, preferably conducted on a day prior to administration of the remaining phases, the following actions are accomplished:

- a. All personnel will be briefed as to the conduct and purpose of the training.
- b. The scoring system will be explained.
- c. The organization of the training area and general administrative and safety procedures will be explained.
- d. All questions will be answered.
- e. The written test will be administered to all section personnel.
- f. The examiner will be provided a copy of the unit SOP to use during evaluation.

TASK 1: Written test.

Conditions

- a. All section members except the section chief will take the written test.
- b. The examiner will select 25 questions from the lists of questions contained in this section.
- c. The scores of the section members will be averaged to determine the section score. Each of the 25 questions is worth 2 points.
- d. Thirty minutes will be allocated for the test.
- e. There is only one correct answer to each question unless otherwise stated.

Written Test Questions

1. An enemy soldier has just surrendered to your unit. Can any of his property be kept as a war trophy?
 - a. Yes.
 - b. No.
2. Can prisoners under the control of your unit be killed if it is certain that they have been engaged in combat against your unit?
 - a. Yes.
 - b. No.
3. A prisoner of war is required to give—
 - a. his name, rank, service number, and date of birth.
 - b. whatever information is requested of him if it has legitimate military significance.
 - c. whatever information is requested of him if it has no military significance.
 - d. no information whatsoever.
4. Can a captured American soldier be required to work in an enemy munitions factory to pay for his food?
 - a. Yes.
 - b. No.
5. An order was given to remove the ears from every enemy killed and to bring the ears back as proof of the kill. Must you obey the order?
 - a. Yes.
 - b. No.
6. Corrosive damage to the interior of an artillery tube results from the—
 - a. failure to clean dust and dirt from the tube before firing.
 - b. friction created as the projectile moves through the bore.
 - c. escape of gas from behind the rotating band.
 - d. absorption of moisture by the residue of primer salts.
7. The maximum range at which you can expect to kill a target with the M16A1 rifle (maximum effective range) is—
 - a. 2,350 meters.
 - b. 375 meters.
 - c. 400 meters.
 - d. 460 meters.
8. The maximum range of the M16A1 rifle is—
 - a. 450 meters.
 - b. 2,400 meters.
 - c. 2,653 meters.
 - d. 3,125 meters.

The following situation pertains to questions 9 through 11.

Situation: You are manning a listening post for your unit. You notice five men in civilian clothes, two carrying rifles and three carrying farm tools. They are entering the village of

Smallville from the southwest. The same five men depart to the northwest. Using the keyword SALUTE to report this information—

9. What does the letter "A" stand for?
 - a. Activity the enemy is engaged in.
 - b. Amount of equipment.
 - c. Azimuth to the enemy.
10. What does the letter "E" stand for?
 - a. Who the enemy is.
 - b. The equipment you observe.
 - c. The estimate of what the enemy is going to do.
11. To whom do you report this information?
 - a. Battery commander.
 - b. Intelligence section.
 - c. Your supervisor.

The following situation refers to questions 12 through 15.

Situation: A chemical attack has occurred in your area. The mess tent is nearby. You have an M258 skin decontaminating kit and you are wearing your protective mask.

12. What is the next thing you do?
 - a. Check the area for casualties.
 - b. Wash your exposed skin.
 - c. Get under cover.
13. Your eyes are irritated and burning. How do you decontaminate them?
 - a. Rinse your eyes with the water in your canteen.
 - b. Wash your eyes with the liquid in the capsules in your M258 kit.
 - c. Get to a medic as soon as possible.
14. You see a thick oily substance on your truck. What is the best substance to use to decontaminate the truck?
 - a. Steam.
 - b. DS2 decontaminating agent.
 - c. Soap and hot water.
15. You are decontaminating your skin with the M258 kit. You put liquid from capsule 1 on a gauze pad and swab your exposed skin. You throw the gauze pad away. What should you do next?
 - a. Check your skin for red spots, which will indicate more chemical contamination.
 - b. Decontaminate your clothing.
 - c. Hit capsule 2 on a hard surface to break the glass vial inside and shake the capsule.

Questions 16 through 18 pertain to loading/unloading/clearing the .50 caliber HBM2 machinegun.

16. Which end of the ammunition belt should be inserted into the feedway when loading a .50 caliber HBM2 machinegun?
 - a. Double-linked end.
 - b. Single-linked end.

17. On the .50 caliber HBM2 machinegun, after the ammunition belt is inserted into the feedway, how many times must you pull the belt to the rear and release it before the weapon is completely loaded?

- a. Once.
- b. Twice.
- c. Three times.

18. How should you insure that the .50 caliber machinegun HBM2 is clear?

- a. Pull the trigger one more time.
- b. Insure the chamber and T-slot are clear of rounds.
- c. Take the ammunition belt out of the feedway.

Questions 19 through 23 involve the actions required to eliminate a stoppage in the .50 caliber HBM2 machinegun when the weapon fails to fire.

19. How many *seconds* should you wait before pulling the handle to the rear to insure that a hangfire does not occur?

- a. 5.
- b. 10.
- c. 30.

20. The weapon is cold, the bolt has been pulled to the rear and released, and the weapon still will not fire. How many *seconds* should you wait before opening the cover?

- a. 5.
- b. 10.
- c. 30.

21. When the weapon is hot and has fired over 150 rounds in 2 minutes, how many *minutes* should you wait before removing the ammunition belt?

- a. 3.
- b. 5.
- c. 10.

22. How should you remove a cartridge from the T-slot?

- a. Remove it with the extractor.
- b. Pull the bolt to the rear.
- c. Push it out of the bottom of the receiver with a screwdriver.

23. How should you remove a ruptured cartridge case from the chamber?

- a. With the ruptured cartridge case extractor.
- b. With a screwdriver.
- c. Turn it in to the armorer.

Questions 24 through 26 involve the actions you must take to eliminate a stoppage in the M60 machinegun so that the weapon will fire.

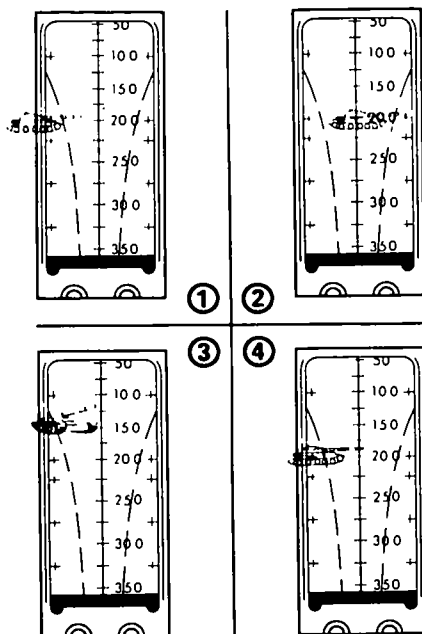
24. Which of the following is the most likely reason the weapon did not fire?

- a. Trigger spring defective.
- b. Bent or broken firing pin.
- c. Insufficient gas pressure.

25. While firing the weapon, you notice that gas pressure is insufficient. What should you do?
- Turn the weapon in to the armorer.
 - Oil the spring.
 - Clean the gas port.
26. The weapon did not cock. What is the most likely reason it did not cock?
- The ammunition is dirty.
 - The gear is broken.
 - The feed lever cam spring is defective.
27. What is the first thing you should do when loading the M60 machinegun?
- Raise the cover.
 - Pull the bolt to the rear.
 - Put the safety on the SAFE position.
28. You are firing the M60 machinegun at a target 2,000 meters from you. The round hit 10 meters to the right of the target. How many clicks should you turn the traversing mechanism to the left?
- 5.
 - 10.
 - 20.

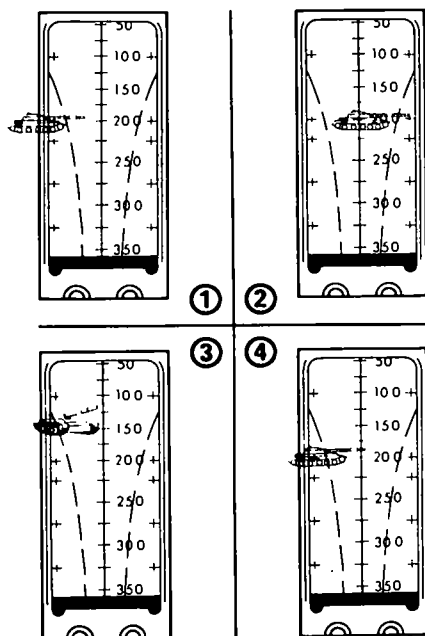
Questions 29 through 36 pertain to the M72A2 LAW.

29. You are preparing to fire the M72A2 LAW. What should you do first?
- Extend the launcher.
 - Perform a prefire safety inspection.
 - Remove the pull pin.
30. When should you remove the pull pin to prepare the M72A2 LAW for firing?
- After the launcher is extended.
 - After you place the launcher on your shoulder.
 - After you make sure the backblast area is clear.
31. What should you do if the M72A2 LAW launcher is not fired?
- Give it to your supervisor.
 - Put it back in the carrying/shipping configuration.
 - Give it back to the ammunition section.
32. Which of the following sight pictures shows the correct method of determining the distance to the tank with the M72A2 LAW?
- 1.
 - 2.
 - 3.
 - 4.



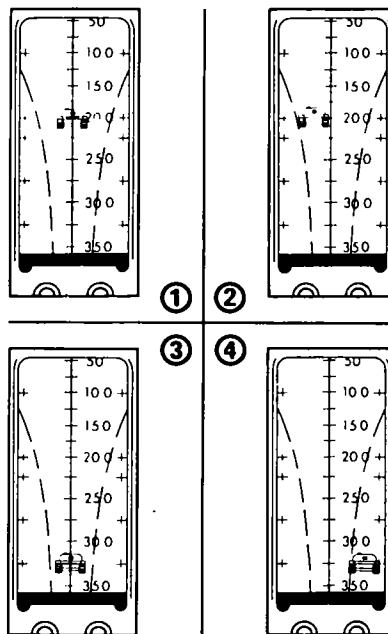
33. You are firing the M72A2 LAW. Which of the following sight pictures indicate the correct position to engage a tank that has stopped 200 meters to your front?

- a. 1.
- b. 2.
- c. 3.
- d. 4.



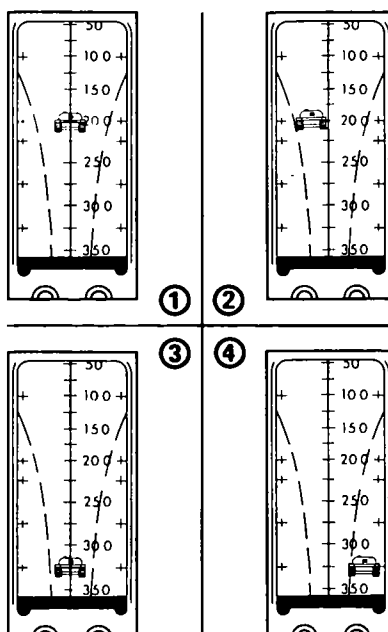
34. You are firing the M72A2 LAW. Which of the following sight pictures shows the correct method of determining the distance to the tank?

- a. 1.
- b. 2.
- c. 3.
- d. 4.



35. Which of the following sight pictures for the M72A2 LAW indicates the correct position to engage a tank that is moving across your front from left to right, at approximately 5 mph, and at a distance of 200 meters?

- a. 1.
- b. 2.
- c. 3.
- d. 4.



36. You are inspecting the M72A2 LAW and you see the sight has a deep scratch in the front lens. What should you do?

- a. Don't worry about it.
- b. Turn the M72A2 LAW in to your ammunition section.
- c. Remove the scratch with rubbing compound.

Questions 37 through 39 require you to answer questions on the actions you would take if your M203 grenade launcher fails to fire.

37. How long should you wait before opening the breech?

- ★ a. 30 seconds.
- b. 1 minute.
- c. 2 minutes.

38. What precaution should you take when unloading the M203?

- a. Let the round fall to the ground.
- b. Catch the ejected round.

39. The primer has been dented. What should you do with the round?

- a. Set it aside and keep it separated from the good rounds.
- b. Put it back in the M203 and fire it again.

40. Your M16A1 rifle fails to fire. What is the first thing you should do to clear the stoppage and fire the weapon?

- a. Pull the bolt to the rear.
- b. Tap up sharply on the base of the magazine.
- c. Put the weapon on SAFE.

Questions 41 through 43 pertain to the following situation:

Situation: You are a cannoneer on a cannon that fires separate-loading ammunition. The cannon has just been fired and you are to clear the powder chamber.

41. What do you do *first*?

- a. Swab the chamber with water.
- b. Announce BORE CLEAR.
- c. Announce SHOT.

42. To whom do you announce BORE CLEAR?

- a. The XO.
- b. The chief of section.
- c. The fire direction center.

43. If you are firing more than one round, what should you announce after each round is fired?

- a. BORE CLEAR and charge.
- b. BORE CLEAR and number of rounds fired.
- c. BORE CLEAR, number of rounds fired, and quadrant.

44. The four lifesaving measures are:

- a. Clear the airway and restore breathing and heartbeat as necessary.
- b. Treat for shock control.
- c. Apply dressing and bandage.
- d. Stop the bleeding.

The proper sequence for these measures is—

- a. A, B, C, D
- b. A, D, C, B
- c. A, D, B, C
- d. B, A, C, D

45. If any member of the battery observes a dangerous situation, he can stop a fire mission already in progress by giving the command—

- a. STOP FIRING.
- b. CANCEL FIRING.
- c. CEASE FIRE.
- d. CHECK FIRING.

46. For best results, the collimator should be emplaced _____ to _____ meters from the howitzer.

- a. 3 to 13
- b. 4 to 15
- c. 0 to 15
- d. 3 to 10

47. Regardless of the distance at which the far aiming post is set, the near aiming post must be emplaced—

- a. about 50 meters from the howitzer.
- b. exactly half the distance to the far aiming post.
- c. as the situation permits.
- d. 100 meters from the howitzer.

48. In a fire command, the number 3167 is pronounced—

- a. thir-tee wun six-tee seven.
- b. thuh-ree thouzand wun six seven.
- c. thuh-ree wun six seven.
- d. three thouzand wun hundred six-tee seven.

49. Number 2 desires the FDC to repeat the deflection. Number 2 should say—

- a. REPEAT DEFLECTION, NUMBER 2.
- b. NUMBER 2, DEFLECTION?
- c. DEFLECTION, NUMBER 2?
- d. SAY AGAIN DEFLECTION, NUMBER 2.

50. When separate-loading ammunition is being fired, the fire command for lot includes two letters, XY. The ammunition component(s) represented by the letter "X" in lot XY is (are)—

- a. propellant.
- b. projectile.
- c. propellant and projectile.
- d. propellant, projectile, and fuze.

51. The primary reason for painting projectiles is to—

- a. prevent rust and corrosion.
- b. provide an easy method of identification.
- c. facilitate handling and storage.
- d. enhance the camouflage of the position.

52. Storing ammunition on dunnage is important only in very hot weather.
- True.
 - False.
53. When storing ammunition, what is the minimum number of inches of dunnage that should be under the ammunition?
- 2.
 - 6.
 - 12.
54. How should a WP projectile be stored?
- On its side and rotated every few hours.
 - On its base.
 - The same as an HC projectile.
55. How should you segregate the ammunition in the firing battery area?
- By size, color and weight.
 - By type, lot and weight zone.
 - By fuze type, lot, and zone.
56. Why must you handle the Beehive round carefully?
- Because it has an aluminum body.
 - Because the explosive filler is very sensitive.
 - Because the fuze can be damaged easily.
57. The 155-mm howitzer white bag propelling charge M4A2 consists of a base charge plus increments numbered—
- 2 through 5.
 - 2 through 7.
 - 4 through 7.
 - 1 through 7.
58. Field artillery cannon ammunition is classified according to type as—
- fixed and separate.
 - separate and semifixed.
 - semifixed and separate loading.
 - separate loading and fixed.
59. To set an M557 PD fuze for delay action, the correct tool is the—
- M63 fuze setter.
 - P-38.
 - M16 fuze wrench.
 - M18 fuze wrench.
60. To prepare an M557 PD fuze for delay action, you must first—
- rotate the selector setting screw to the horizontal position.
 - rotate the fuze body to the proper setting.
 - put a supplementary charge in the fuze well.
 - move the interrupter out of the flash channel.

61. While a 155-mm howitzer (cold tube) is being fired, an ammunition malfunction occurs. You have waited 2 minutes before removing and inspecting the primer. The primer is dented and has fired. Now, how long must you wait before you open the breech?

- a. 2 minutes.
- b. 5 minutes.
- c. 8 minutes.
- d. 10 minutes.

62. The type of fuze that has the capability of detonating the projectile in the air, at a predetermined height above the ground, is the—

- a. superquick fuze.
- b. concrete-piercing fuze.
- c. proximity fuze (VT).
- d. delay fuze.

63. If the MTSQ fuze M564 is to be used for impact superquick action, the fuze must be set at—

- a. 90.0.
- b. 95.5.
- c. 98.0.
- d. 00.0.

64. A misfire occurs while a 105-mm M101A1 is being fired. You find that the primer is not dented. You know that the cause of the malfunction is a defective—

- a. powder charge.
- b. firing mechanism.
- c. primer.
- d. igniting charge.

65. The fuze wrench used to seat and tighten a fuze into a standard HE projectile is the—

- a. M16.
- b. M63.
- c. M18.
- d. M27.

66. The fuze setter that has a slip clutch in its handle that prevents the ring on a time fuze from being turned in a counterclockwise direction is the—

- a. M28.
- b. M34.
- c. M35.
- d. M63.

67. The threaded steel plug that facilitates the handling of separate-loading projectiles is called the—

- a. closing plug.
- b. nose plug.
- c. eyebolt lifting plug.
- d. fuze plug.

68. When the distant aiming point method of boresighting is used, the minimum distance between the aiming point and the weapon should be—

- a. 7200 meters.
 - b. 1300 meters.
 - c. 1400 meters.
 - d. 1500 meters.
69. In boresighting by the testing target method, the testing target must be located at least _____ meters in front of the howitzer.
- a. 50
 - b. 60
 - c. 4 to 15
 - d. 100
70. On a weapon that fires separate-loading ammunition, excessive blowback around the breechblock may mean the split rings are less than 180° apart.
- a. True.
 - b. False.
71. Fire control alinement tests should be performed—
- a. at the discretion of the battery commander.
 - b. every 3 months when firing or once each year if no firing takes place.
 - c. when fire is inaccurate for no apparent reason.
 - d. All of the above.

Questions on the 105-mm Howitzer M102

72. The M102 recoil mechanism oil reserve should be reestablished when the oil index indicator rod protrudes as much as (select the MOST APPLICABLE choice)—
- a. three thirty-seconds of an inch.
 - b. one-eighth of an inch.
 - c. five thirty-seconds of an inch.
 - d. three-sixteenths of an inch.
73. The M102 howitzer is raised to the travel position or lowered to the firing position by the—
- a. spring-loaded leveler.
 - b. mechanical actuator.
 - c. wheel assemblies.
 - d. roller supports.
74. The yoke that contains the recoil oil filling valve on the M102 is the—
- a. first yoke.
 - b. second yoke.
 - c. third yoke.
 - d. fourth yoke.
75. The assembly on the M102 that prevents the carriage from tipping forward when the recoiling parts return to the battery is the—
- a. respirator assembly.
 - b. buffer assembly.
 - c. regulator body assembly.
 - d. support assembly.

76. What prevents the breechblock of the M102 from closing before the round is loaded?
- Extractors.
 - Torsion helical spring.
 - Operating crank.
 - Operating handle.
77. The knob on the panoramic telescope M113 that will simultaneously turn the sight rotating head, the reset counter digits, and the azimuth counter digits is the—
- reset counter knob.
 - gunner's aid counter knob.
 - elevation knob.
 - azimuth knob.

Questions on the 105-mm Howitzer M101A1

78. The pneumatic respirator on the 105-mm howitzer M101A1 will provide minimum counterrecoil buffing action when placed on a setting of—
- 0.
 - 1.
 - 2.
 - 3.
79. The component of the 105-mm howitzer M101A1 that supports the overhanging weight of the barrel and breech assembly and recoil mechanism during travel is the—
- equilibrating mechanism.
 - cradle lock strut.
 - cradle traveling lock.
 - spring equilibrator.
80. On the M101A1, the sleigh with recoil mechanism is attached to the stationary cradle by the—
- piston rod outer locking nut.
 - breech ring locking screw.
 - front yoke of the sleigh.
 - howitzer locking ring.
81. On the M101A1, when the command to fire is given, which hand should you use to pull the lanyard?
- Right.
 - Left.
 - Right or left.
82. When the M101A1 is fired with maximum charge, the maximum *allowable* recoil is—
- 46 inches.
 - 44 inches.
 - 42 inches.
 - 40 inches.

83. The recoiling parts of the M101A1 are held in the in-battery position by the force of the—
- oil pressure compressing the nitrogen in the recuperator cylinder.
 - compressed oil in the recoil cylinder.
 - compressed oil in the counterrecoil cylinder.
 - compressed spring in the equilibrator.

★ Questions on the 155-mm Howitzer M109/M109A1/M109A2/M109A3

- ★84. The equilibrator system of the M109/M109A1/A2/A3 must be adjusted by increasing or decreasing the—
- length of the temperature-adjusting screws.
 - tension in the equilibrator springs.
 - power to the electric-motor-driven hydraulic system pump.
 - pressure in the equilibrator system.
- ★85. If the M109/M109A1/A2/A3 is not fired, the chamber evacuator valves should be removed and cleaned—
- daily.
 - weekly.
 - monthly.
 - semiannually.
- ★86. To engage the high-speed manual traverse on the M109/M109A1/A2/A3, the operator moves the MANUAL POWER selector to the—
- right and the speed selector lever to the right.
 - right and the speed selector lever to the left.
 - left and the speed selector lever to the right.
 - left and the speed selector lever to the left.
- ★87. The number of rounds that can be carried in the ammunition racks in the M109/M109A1 (M109A2/A3) is—
- 28 (36).
 - 36 (42).
 - 42 (50).
 - 50 (58).
- ★88. The maximum rate of fire for the M109/M109A1/A2/A3 is—
- 1 round per minute for 3 minutes.
 - 2 rounds per minute for 4 minutes.
 - 3 rounds per minute for 4 minutes.
 - 4 rounds per minute for 3 minutes.
- ★89. The zero pressure check on the M109/M109A1/A2/A3—
- normally is performed by an artillery mechanic.
 - indicates the amount of precharged nitrogen in the main accumulator.
 - indicates if there is sufficient hydraulic oil in the main powerpack reservoir.
 - All of the above.

Questions on the 155-mm Howitzer M114A1(A2)

90. One complete turn of the traversing handwheel of the M114A1(A2) will move the tube—
- 10.3 mils.
 - 12.6 mils.
 - 14.8 mils.
 - 16.1 mils.
91. The proper amount of recoil oil reserve in the replenisher of the M114A1(A2) will be indicated when the replenisher piston rod measures—
- 3½ inches.
 - 5½ inches.
 - 7½ inches.
 - 9½ inches.
92. The proper volume of oil in the recoil mechanism system of the M114A1(A2) is maintained at all times by action of the—
- floating piston.
 - recuperator.
 - replenisher.
 - variable recoil and cam assembly.
93. The M114A1(A2) can be traversed _____ mils to the left from the center of traverse.
- 418
 - 428
 - 438
 - 48
94. The replenisher oil reserve on the M114A1(A2) should be checked prior to firing and also—
- after firing.
 - after every 10 rounds fired.
 - after every 100 rounds fired.
 - upon completion of the first fire mission.

★ **Questions on the 8-Inch Self-Propelled Howitzer M110/M110A1/M110A2**

- ★95. In boresighting the elbow telescope on the M110/M110A1/A2, corrections in azimuth and elevation are made by—
- changing the reticle in the telescope.
 - adjusting the elbow telescope mount M138.
 - adjusting the elevation quadrant M15.
 - moving the fine index on the telescope head.
- ★96. The loader-rammer assembly of the M110/M110A1/A2 is operated by—
- manual power only.
 - manual or electric power.

- c. electrical and hydraulic power.
- d. manual or hydraulic power.

- ★97. The manual traverse control on the M110/M110A1/A2 is intended to be used only—
- a. during two-man, two-sight direct firing.
 - b. as a backup in case of power failure.
 - c. when the howitzer is within 2.0 mils of the desired deflection.
- ★98. The two recoil spade cylinders that raise or lower the recoil spade on the M110/M110A1/A2 are controlled by a lever located at the—
- a. left rear of the vehicle.
 - b. right rear of the vehicle.
 - c. gunner's seat position.
 - d. assistant gunner's seat position.
- ★99. To overcome friction buildup on the recuperator floating piston that has caused the recuperator oil index of the M110/M110A1/A2 to stick, it is necessary to—
- a. place the power takeoff switch on the ON position.
 - b. position and hold the oil pump switch in the OVERRIDE position, and place the retracting control valve handle in the RETURN position.
 - c. notify support maintenance personnel.
- ★100. The control for the fixed fire extinguisher system of the M110/M110A1/A2 is located in the—
- a. engine compartment.
 - b. operator's compartment.
 - c. battery compartment.
 - d. turret well.
- ★101. To reestablish the recuperator oil reserve of the M110/M110A1/A2, it is necessary to place the oil pump motor switch in the ON position and to place the retracting control handle in the—
- a. RETRACT position.
 - b. NORMAL position.
 - c. HOLD position.
 - d. RETURN position.
102. When you build up the pressure on the main accumulator with the PTO pump, the engine should be idled between _____ rpm.
- a. 1,200 and 2,000
 - b. 1,000 and 1,500
 - c. 600 and 1,200
103. Normally, the main oil pump is used to—
- a. emplace the spade.
 - b. move the tube in or out of battery.
 - c. replenish the system.
 - d. maintain pressure.

Questions on the 175-mm Gun M107

104. Normally, the tube of the M107 will begin minimum recoil at _____ of elevation.
- 178 mils
 - 480 mils
 - 950 mils
 - 1,100 mils
105. The engine-driven hydraulic pump, used to initially charge the accumulator of the hydraulic system of the M107, should not be operated—
- in excess of 1,200 rpm.
 - for raising or lowering the spade.
 - to save the vehicle batteries.
106. The M107 is classified as a—
- light field artillery weapon.
 - medium field artillery weapon.
 - heavy field artillery weapon.
 - very heavy field artillery weapon.
107. The recuperator cylinder of the M107 is charged when the retracting control valve handle is placed in the—
- RETRACT position.
 - NORMAL and HOLD positions.
 - OFF position.
 - RETURN position.
108. When electrical power from one M107 is used to start another M107, damage to the voltage regulator and rectifier of the vehicle being started can be prevented by—
- reversing the polarity of the battery cables.
 - turning the master switch of the receiving vehicle to OFF.
 - using high-capacity jumper cables.
 - routing the incoming current around the batteries of the receiving vehicle.
109. The limits of elevation of the M107 are governed by—
- the solenoid valve circuit.
 - the elevating hydraulic control.
 - the elevating motor brake.
 - stops on the cradle.
110. The oil reserve for the recoil cylinder of the M107 recoil mechanism is contained in the—
- replenisher cylinder.
 - recuperator cylinder.
 - counterrecoil cylinder.
 - recoil cylinder.

111. There are _____ road wheel arms on the M107 with hydraulic lockout cylinders.
- a. two
 - b. four
 - c. six
 - d. eight

Questions for Vehicle Drivers

112. When preparing to go up a hill, a tracked vehicle driver should—
- a. always place the vehicle in the lowest range.
 - b. choose the range that will carry the vehicle over the hill.
 - c. leave the vehicle in the range it is in until the engine "lugs down," then shift to a low range.
 - d. always bring his vehicle to a complete stop, then place the selector in the lowest range until the hill is negotiated.
113. Most vehicle skids are the result of—
- a. vehicles operating on steel tracks.
 - b. vehicles operating on rubber tracks or pads.
 - c. vehicles operating on slippery, unsafe roads.
 - d. vehicles being driven too fast for the road surface conditions.
114. When a vehicle guide brings his hands together in front of him, he means—
- a. slow down.
 - b. stop your engine.
 - c. stop.
 - d. go straight ahead.
115. Unequal track tension will cause—
- a. no difference in riding qualities.
 - b. no difference in driving qualities.
 - c. the vehicle to jump or steer erratically.
 - d. the vehicle to pull to one side.
116. When one track is spinning, power can best be applied to the track by—
- a. chaining the slipping track to a road wheel arm.
 - b. applying steering control to the slipping track with the transmission in neutral.
 - c. applying steering action with the transmission in driving range.
 - d. moving the selector lever rapidly from drive to reverse range with the engine accelerated and applying no steering action.
117. When a vehicle approaches from the rear to pass, you should—
- a. be warned by the vehicle commander, keep to the right, and allow it to pass.
 - b. increase speed so that the vehicle will not pass.
 - c. disregard the vehicle until the next scheduled halt, when it can pass.
 - d. move to the right, halt, and motion the vehicle to pass.

118. If the red master warning light comes on while the vehicle is in operation, the driver should—

- a. determine the source of the trouble at the next scheduled halt.
- b. proceed, but inform the vehicle commander and let him investigate.
- c. stop the vehicle immediately, determine the source of trouble, and wait for a mechanic.
- d. disregard the light, as most warning panels do not function properly.

119. A throat-cutting motion with the right hand and arm by the vehicle guide is the signal for—

- a. cranking the engine.
- b. increasing speed.
- c. turning off headlights.
- d. stopping the engine.

120. To cross a ditch or a small ravine, a track driver should—

- a. back off to get space for a maximum-speed approach and jump the vehicle over the ditch.
- b. move slowly over the edge in low range, brake until the vehicle eases into the ditch, then accelerate enough to carry the vehicle up and over the other side.
- c. move rapidly into the obstacle in high range at maximum engine rpm and maintain full acceleration until the obstacle is cleared.
- d. move slowly to the edge of the ditch, then accelerate fully until the obstacle is cleared.

121. In crossing a soft field of mud or sand—

- a. follow in the tracks of the vehicle ahead (if applicable).
- b. zigzag across the area as fast as possible.
- c. move as straight and steadily as possible; do not track the vehicle ahead (if applicable).
- d. stop and reverse the vehicle occasionally to remove the sand or mud from the tracks.

122. How will you know when a scheduled lubrication is due on your vehicle?

- a. Check the daily DA Form 2408-1 (Equipment Daily or Monthly Log).
- b. Check the monthly DA Form 2408-1 (Equipment Daily or Monthly Log).
- c. Check the DA Form 2408-14 (Uncorrected Fault Record) in the logbook.
- d. Check the DA Form 2404 (ESC) (Equipment Inspection and Maintenance Worksheet) in the logbook.
- e. Ask the motor sergeant to check the DA Form 2406 (Materiel Readiness Report).

123. In which publications should you look for assistance in performing the BDA checks? (More than one answer required.)

- a. Daily DA Form 2408-1 (Equipment Daily or Monthly Log).
- b. Monthly DA Form 2408-1 (Equipment Daily or Monthly Log).
- c. Lubrication order (LO).
- d. Checks and services table in the technical manual (TM).
- e. DA Form 2407 (Maintenance Request).
- f. DA Form 2408-10 (Equipment Component Register).
- g. DA Form 2408-4 (Weapon Record Data).

124. On what form should you record the operational status of the vehicle?

- a. Daily DA Form 2408-1 (Equipment Daily or Monthly Log).
- b. Monthly DA Form 2408-1 (Equipment Daily or Monthly Log).
- c. DA Form 2400 (Equipment Utilization Record).

- d. DA Form 2408 (Equipment Log Assembly).
- e. DA Form 2404 (Equipment Inspection and Maintenance Worksheet).
- f. The daily checks and services lists.

Directions: A series of true or false statements follows. If *any* part of a statement is false, the entire statement is false. Indicate your answer by marking the appropriate space on your answer sheet.

- 125. Before an engine is stopped, it should be cooled by idling for a period of time.
 - a. True.
 - b. False.
- 126. Permitting vehicles to stand overnight with a low fuel level could result in water in the fuel.
 - a. True.
 - b. False.
- 127. The best way to warm up an engine is to race it several times.
 - a. True.
 - b. False.
- 128. It is not necessary to check for a hydrostatic lock in cold weather, because gasoline does not vaporize easily at low temperatures.
 - a. True.
 - b. False.
- 129. The use of indirect-vision devices by tracked vehicle drivers does not reduce their driving capability.
 - a. True.
 - b. False.
- 130. It is permissible to start or operate a tracked vehicle without serviceable fixed fire extinguishers.
 - a. True.
 - b. False.

Section IV. EVALUATION PHASE II

TASK 2: Preparation for deliberate occupation of a prepared position.

Conditions

The chief of section is in the unit motor pool with his crew and is read the following situation by the evaluator:

YOUR SECTION IS PREPARING TO DEPART THE UNIT MOTOR POOL FOR A DELIBERATE OCCUPATION OF A FIRING POSITION. THE FIRST SERGEANT HAS JUST INFORMED YOU THAT THE ADVANCE PARTY WILL DEPART IN 15 MINUTES AND THAT HE WANTS A GUN GUIDE FROM YOUR SECTION READY TO DEPART AT THAT TIME. THE CFB HAS ALSO TOLD YOU THAT THE MAIN BODY WILL DEPART IN 30 MINUTES AND THAT YOUR SECTION SHOULD MAKE ALL NECESSARY PREPARATIONS FOR THE MOVEMENT, TO INCLUDE THE BEFORE-OPERATION CHECKS AND SERVICES ON THE CANNON AND PRIME MOVER/CARGO CARRIER.

Evaluation Checklist

Did the section have all section equipment installed/stowed in accordance with all applicable manuals and unit loading plans?

Were all necessary items on hand for performing the before-operation checks and services on the cannon and prime mover/cargo carrier; i.e., basic issue items, operator's manuals, lubrication orders, DA Forms 2404, cleaning materials, and log books?

Was the heading of two DA Forms 2404 completed properly for the conduct of a daily inspection on the cannon and prime mover/cargo carrier?

Did the chief of section use all crewmembers present to inspect both the cannon and prime mover/cargo carrier in an orderly and efficient manner?

Did the section inspect each item listed in the "before" column of the preventive maintenance checks and services (PMCS) tables of the operator's manuals for the cannon and prime mover/cargo carrier?

Did the section correct all faults discovered that they were authorized to correct in accordance with the PMCS tables and troubleshooting tables of the operator's manuals for the cannon and prime mover/cargo carrier?

Did the section use DA Forms 2404 to list all faults that they were not able to correct and that were not already listed on the DA Forms 2408-14 for the cannon and prime mover/cargo carrier?

Did the chief of section or driver make proper entries on the DA Forms 2408-1 (daily) for the cannon and prime mover/carrier at the conclusion of the before-operation checks and services?

Was the gun guide ready to depart with all necessary equipment at the time prescribed?

GO	NO GO

Scoring

For each **go** rating, 8 points will be awarded, for a maximum of 72 points.

For each **no go** rating, 0 points will be awarded.

TASK 3: Disassembly of breech mechanism.

Conditions

After giving the howitzer section approximately 30 minutes to complete task 2 above, the evaluator should read the following situation to the chief of section:

DURING THE CONDUCT OF THE BEFORE-OPERATION CHECKS AND SERVICES ON YOUR CANNON, YOU NOTED A MALFUNCTION IN THE BREECH MECHANISM. IN ORDER TO TROUBLESHOOT THE EXACT CAUSE, YOU DECIDE THAT YOU MUST DISASSEMBLE THE BREECH MECHANISM. YOU MAY SELECT ANY MEMBER(S) OF YOUR SECTION TO PERFORM THIS TASK. HOWEVER, YOU MAY NOT PHYSICALLY PERFORM ANY ACTION. YOU NOW HAVE 1 MINUTE TO SELECT THE SECTION MEMBER(S) TO PERFORM THIS TASK AND ASSEMBLE ALL REQUIRED TOOLS AND MANUALS.

At the end of 1 minute, the evaluator should give the following instructions to the section member(s) performing the task:

YOU ARE TO DISASSEMBLE THE BREECH MECHANISM, TO INCLUDE REMOVAL OF BREECHBLOCK, DISASSEMBLY OF FIRING MECHANISM, AND DISASSEMBLY OF OBTURATOR GROUP (AS APPLICABLE). EVEN THOUGH THIS IS A TIMED EXERCISE, PERFORM ALL ACTIONS IN THE PRESCRIBED SAFE MANNER. ARE YOU READY?....GO!

Evaluation Checklist

Were the breechblock, obturator group, and firing mechanism (as applicable) disassembled in accordance with the appropriate operator's manual?

GO	NO GO

Scoring

If a **go** rating is awarded, the disassembly will be graded according to speed of execution (see table C-1 below).

If a **no go** rating is awarded, 0 points will be awarded for this task.

Table C-1. Scoring—Breech Mechanism Disassembly

★	M110/M110A1/A2/M107	M101A1	M102	M114A1(A2)	Points
	M109/M109A1/A2/A3/ M198				
	0 - 3:30	0 - 1:00	0 - 3:00	0 - 3:45	49
	3:31 - 4:00	1:01 - 1:15	3:01 - 3:25	3:46 - 4:05	36
	4:01 - 4:20	1:16 - 1:25	3:26 - 3:40	4:06 - 4:20	24
	4:21 - 4:30	1:26 - 1:30	3:41 - 3:45	4:21 - 4:30	12
	Longer than 4:30	Longer than 1:30	Longer than 3:45	Longer than 4:30	0

C1, FM 6-50

TASK 4: Assembly of breech mechanism.

Conditions

After evaluating task 3, the evaluator should read the following to the chief of section and the section member(s) previously selected for disassembly of the breech:

ASSUME THAT YOU HAVE DISCOVERED THE MALFUNCTION IN THE BREECH MECHANISM. AT THIS TIME, YOU WILL BE EVALUATED ON YOUR ABILITY TO REASSEMBLE THE BREECH MECHANISM IN ITS ORIGINAL CONFIGURATION. ARE YOU READY?....GO!

Evaluation Checklist

Was the breech mechanism properly assembled in accordance with the appropriate operator's manual?

GO	NO GO

Scoring

If a **go** rating is awarded, the assembly will be graded according to speed of execution (see table C-2 below).

If a **no go** rating is awarded, 0 points will be awarded for this task.

Table C-2. Scoring—Breech Mechanism Assembly

★ M110/M110A1/A2/M107 M109/M109A1/A2/A3/ M198	M101A1	M102	M114A1(A2)	Points
0 - 4:00	0 - 1:45	0 - 3:30	0 - 4:15	49
4:01 - 4:30	1:46 - 2:00	3:31 - 4:00	4:16 - 4:35	36
4:31 - 4:50	2:01 - 2:10	4:01 - 4:20	4:36 - 4:50	24
4:51 - 5:00	2:11 - 2:15	4:21 - 4:30	4:51 - 5:00	12
Longer than 5:00	Longer than 2:15	Longer than 4:30	Longer than 5:00	0

TASK 5: Performance of the micrometer test on the gunner's quadrant.

Conditions

After evaluating task 4, the evaluator should read the following to the howitzer chief of section:

BECAUSE OF RECENT FIRING INACCURACIES, THE XO HAS TOLD EACH HOWITZER SECTION TO IMMEDIATELY PERFORM THE MICROMETER AND END-FOR-END TESTS ON THEIR GUNNER'S QUADRANTS. YOU (OR ANY OF YOUR SECTION MEMBERS) ARE TO PERFORM THE MICROMETER TEST AND ANNOUNCE ANY ERROR AND CORRECTIVE ACTION TO TAKE. AT THE CONCLUSION OF THE MICROMETER TEST, DO NOT REMOVE THE GUNNER'S QUADRANT FROM THE BREECH UNTIL TOLD TO DO SO BY THE EVALUATOR. ARE YOU READY?....GO!

Evaluation Checklist

Did the examinees follow the correct procedures in performing the micrometer test?

Was the examinee able to determine if the micrometer knob was or was not in error and the action to be taken if it was in error?

GO	NO GO

Scoring

If the examinee receives all **go** ratings, the score will be determined by the speed of execution (see table C-3 below).

If the examinee receives any **no go** ratings, 0 points will be awarded.

Table C-3. Scoring—Micrometer Test

TIME	POINTS
0:00 - 0:30	40
0:31 - 0:50	32
0:51 - 1:05	24
1:06 - 1:15	16
1:16 - 1:20	8
Longer than 1:20	0

TASK 6: Performance of the end-for-end test.

Conditions

After evaluating task 5, the evaluator should read the following to the section chief:

NOW THAT THE MICROMETER TEST HAS BEEN PERFORMED, YOU (OR ANY MEMBER OF YOUR SECTION) ARE TO PERFORM THE END-FOR-END TEST ON YOUR GUNNER'S QUADRANT. AT THE CONCLUSION OF THE TEST—

1. LEAVE THE GUNNER'S QUADRANT ON THE BREECH,
2. ANNOUNCE THE ERROR TO THE EVALUATOR, AND
3. ANNOUNCE TO THE EVALUATOR IF THE QUADRANT IS SERVICEABLE OR UNSERVICEABLE.

ARE YOU READY?.....GO!

Evaluation Checklist

Did the examinee follow the correct procedures in performing the end-for-end test?

Was the correct quadrant error announced by the examinee?

Was the quadrant declared unserviceable if the error exceeded +0.4 mil or declared serviceable if the error was +0.4 mil or less?

GO	NO GO

Scoring

If the examinee receives all **go** ratings, the score for the task will be determined by the speed of execution (see table C-4).

If the examinee receives any **no go** ratings, 0 points will be awarded.

Table C-4. Scoring—End-for-End Test

TIME	POINTS
0 - 1:00	40
1:01 - 1:30	33
1:31 - 1:50	26
1:51 - 2:05	20
2:06 - 2:15	13
2:16 - 2:20	7
Longer than 2:20	0

Section V. EVALUATION PHASE III

General

During this phase, the gun guide will prepare a designated location for occupation by the section. The section will move to this location, make a deliberate occupation, and prepare for firing.

TASK 7: Preparation of position by the gun guide.

Conditions

The gun guide will be required to prepare a position for a deliberate occupation. Upon his arrival in position, the gun guide will be given a detailed briefing to include—

- The specific location for his howitzer.
- The direction of fire.
- The initial deflection from the aiming circle.
- The route into and through the simulated battery position area.

Upon completion of his briefing, he will be allowed 15 minutes in which to prepare the position.

Evaluation Checklist

Did the guide—

Provide initial security for the simulated advance party in the position area?

Have all the equipment required, according to the unit SOP, upon his arrival in the new position?

Accurately emplace the howitzer stakes along the azimuth of fire to an accuracy of ± 10 mils?

Record the azimuth of fire and initial deflection to the aiming circle?

Accurately pace the distance to the aiming circle?

GO	NO GO

Walk the route from the entrance point to the howitzer location?

Continuously improve the position?

Properly lead the weapon into position by use of standard hand and arm signals?

Guide the howitzer so that it was parallel with the marking stakes to an accuracy of ± 10 mils?

Report the azimuth of fire and the initial deflection to the section chief and establish wire communications with the aiming circle?

GO	NO GO

Scoring

For each **go** rating, 6 points will be awarded, for a maximum of 60 points.

For each **no go** rating, 0 points will be awarded.

TASK 8: Emplacing the cannon.

Conditions

The section is occupying a new position and the cannon position has been designated to the chief of section.

Evaluation Checklist

Did the driver follow the gun guide at a safe speed and distance?

After stopping in position, was the weapon emplaced within the "time to emplace" standard stated in the appropriate ARTEP? Was the travel lock disengaged, were spades emplaced as required, was the muzzle plug removed, was optical equipment installed, etc.?

Did the howitzer/prime mover driver follow proper shutdown procedures after the howitzer was in position?

Was the initial primary concern of the section to establish the capability to fire?

Did each section member perform his duties with minimum orders?

GO	NO GO

Scoring

For each **go** rating, 12 points will be awarded, for a maximum of 60 points.

For each **no go** rating, 0 points will be awarded.

TASK 9: Laying the cannon for direction.

Conditions

Preparations will be made to lay the cannon by wire.

The cannon is in position and the aiming point is identified to the gunner.

Evaluation Checklist

Did the gunner use the initial deflection reported by the gun guide?

Was the howitzer laid at the laying elevation?

Were proper commands used during laying?

Were bubbles centered and correct settings made during laying?

Did the section chief verify the sight picture, laid deflection, and bubbles when the howitzer was laid?

Was the howitzer laid to an accuracy of 0 mils?

Did the gunner verify the lay of his howitzer by making a reciprocal check (simulated) with another howitzer?

Did each section member perform his duties with minimum orders?

GO	NO GO

Scoring

For each **go** rating, 7 points will be awarded, for a maximum of 56 points.

For each **no go** rating, 0 points will be awarded.

TASK 10: Establishing aiming points.

Conditions

The howitzer has been laid for direction.

The unit mission will allow the establishment of alternate aiming points once the collimator is emplaced.

Evaluation Checklist

Were the collimator and aiming posts prepared for use while the howitzer was being laid?

Was the collimator emplaced and ready for use as the aiming point within 1 minute after the howitzer was laid for deflection?

Were the aiming posts properly emplaced as time permitted?

Was a DAP selected and recorded as time permitted?

Did each section member perform his duties with minimum orders?

GO	NO GO

Scoring

For each **go** rating, 10 points will be awarded, for a maximum of 50 points.

For each **no go** rating, 0 points will be awarded.

TASK 11: Performing prefire checks.

Conditions

The section has just occupied a position and the howitzer has been laid for direction.

The battery has traveled over rough terrain en route to this position.

Evaluation Checklist

Were prefire checks properly performed?

As the situation permitted, was boresight verified within 3 minutes (by DAP method)?

Were the howitzer and section areas neat and orderly?

Were conditions allowed to exist that would make the howitzer unsafe during firing?

Were angle of site and range to crest announced accurately by the section chief?

Did the section chief report when his section was in order?

Was section gear arranged according to unit SOP?

Were all pertinent section data recorded and posted as appropriate (laid deflection and deflection to aiming posts, collimator, and alternate aiming points)?

Were after-operation maintenance checks performed?

Did each section member perform his duties with minimum orders?

GO	NO GO

Scoring

For each go rating, 7 points will be awarded, for a maximum of 70 points.

For each no go rating, 0 points will be awarded.

TASK 12: Position improvement.

Conditions

The section will be allowed 30 minutes to occupy and improve the position. Time for the occupation will start when the howitzer enters the battery area at a designated entrance point. Camouflage nets will not be erected during the improvement of the position phase because of time limitations.

The section chief will give all reports to the examiner, who will act as the executive officer for reporting purposes.

Upon occupation of position, the examiner will inform the section chief of—

His sectors of responsibility for direct fire for both the howitzer and the secondary armament, as appropriate.

His supplementary position (within 100 meters of the howitzer position).

Evaluation Checklist

Were natural materials, when available, used to help camouflage the section position?

Did the section maintain track discipline and camouflage exposed tracks, to include reflective surfaces?

Were noise discipline and light discipline maintained (as appropriate)?

GO	NO GO

Was the section in the proper uniform throughout the occupation?

Were the range cards prepared for both the howitzer and the secondary armament for primary and supplementary positions?

Did each section member perform his duties with minimum orders?

GO	NO GO

Scoring

For each **go** rating, 9 points will be awarded, for a maximum of 54 points.

For each **no go** rating, 0 points will be awarded.

Section VI. EVALUATION PHASE IV

TASK 13: Conduct of indirect fire missions.

Conditions

The FDC has announced a fire mission.

The section chief will be given four individual cards with the firing data for each round.

Example:

CARD 1

INITIAL COMMANDS

Round 1

Section chief commands:

FIRE MISSION, BATTERY ADJUST, CHARGE 5, DEFLECTION 2938, QUADRANT 348.

SUBSEQUENT COMMANDS

Rounds 2 through 5

Section chief commands:

DEFLECTION (so much), QUADRANT (so much).

For rounds 2 and 3, the size of the deflection and quadrant shifts from the last round fired will be—

Deflection: 20 to 40 mils.

Quadrant: 20 to 30 mils.

For rounds 4 and 5, high-angle fire will be required. The size of the deflection and quadrant shifts will be—

Deflection: 50 to 80 mils.

Quadrant: 600 to 800 mils.

Note. The tube will be returned to loading elevation after each round is fired (if applicable). The M107 gun will fire rounds 4 and 5 at low angle and will be graded at the low angle time standards.

The time for each test will begin when the section chief states the first word of the command and will end when the appropriate cannoneer has fired the weapon.

The cannoneers will perform all of the actions required to fire the weapon, to include using dummy ammunition, if available. Firing will be on the command of the section chief.

Evaluation Checklist and Scoring

4 missions x 30 points per mission = 120 points possible.

Were all bubbles exactly centered when round was fired?

-5 for any uncentered bubble (max cut -5)

Was panoramic telescope correctly alined on aiming point when round was fired?

-5 if not alined (max cut -5)

Were the correct data fired?

-5 for any incorrect data (max cut -5)

Were correct and complete commands issued by all section members (SET, READY, CLOSE, etc.)?

-1 for each incorrect or omitted command (max cut -5)

★ Maximum Possible Points	Round No.	M109/ M109A1/ A2/A3	M110/ M110A1/A2 M107	M114A1/A2	M101A1	M102	Penalty Points
6	1	18 sec	18 sec	18 sec	18 sec	18 sec	1 point for each second over
12	2 and 3	13 sec	13 sec	13 sec	13 sec	13 sec	
12	4 and 5	20 sec	20 sec	35 sec	25 sec	25 sec	

TASK 14: Prepare nonnuclear ammunition for firing.

Conditions

Dummy ammunition will be available.

The section chief will be given four 3 x 5 cards that will require the section to prepare selected nonnuclear ammo for firing.

Standard data: Tested section is adjusting piece, shell HE, lot X(Y), FZ Q.

CARD 1

Section chief commands:

FIRE MISSION, BATTERY ADJUST, DO NOT LOAD, CHARGE 5, DEFLECTION 3211, QUADRANT 531.

CARD 2

Use a different charge and fuze delay.

Evaluation Checklist, Cards 1 and 2

Was ammunition sufficiently protected as dictated by the tactical situation?

Was ammo prepared in accordance with fire commands?

Were PD-fuzed projectile and propellant prepared in 30 seconds or less, as announced?

Were delay-fuzed projectile and propellant prepared in 30 seconds or less, as announced?

Was propellant cut to announced charge?

GO	NO GO

CARDS 3 and 4

Use different charge, fuze VT, and fuze TI with appropriate settings.

Evaluation Checklist, Cards 3 and 4

Was ammo sufficiently protected as dictated by the tactical situation?

Was ammo prepared in accordance with fire commands?

Were VT-fuzed projectile and propellant prepared in 40 seconds or less, and was time set to an accuracy of 0 seconds?

Were MTSQ-fuzed projectile and propellant prepared in 40 seconds or less, and was time set to an accuracy of 0.1?

Was propellant cut to announced charge?

GO	NO GO

Scoring

For each **go** rating, 5 points will be awarded; maximum 100 points.

For each **no go** rating, 0 points will be awarded.

TASK 15: Planned priority targets.

Conditions

FDC has announced the firing data for planned targets.

FDC has designated a priority target from the planned target list.

FDC will announce the section and target number to be fired.

Evaluation Checklist

Has the section prepared a section data card for planned targets, to include target numbers, shell, lot, fuze, time, deflection, and quadrant?

Was the howitzer laid on the priority target within 30 seconds of the command from FDC?

Was the charge cut?

Was a fuze with appropriate setting mated to the announced projectile?

Was the projectile in the loading tray (if applicable)?

GO	NO GO

Was the weapon laid for direction and elevation (loading elevation, if necessary)?

Was the weapon fired within 10 seconds of the command from FDC?

GO	NO GO

Scoring

For each **go** rating, 6 points will be awarded, for a maximum of 42 points.

For each **no go** rating, 0 points will be awarded.

TASK 16: Conduct of direct fire.

★Note. If an artillery direct fire trainer (ADFT) is available, you should administer the evaluation contained as an appendix to TM 9-6920-357-10-2 instead of the following evaluations.

Conditions

A stationary target will be emplaced 400 to 800 meters from the howitzer to simulate a moving target.

The section chief will be given a series of 3x5 cards that will require the section to use direct laying procedures.

The two-man, two-sight system will be used by all sections, except that the M114A1 will use the two-man, one-sight system.

The following sample situation cards may be used for all weapons. The examiner should prepare situation cards that are varied and that avoid routine or similar ranges.

CARD 1

A Soviet T62 tank is approaching your battery position and is moving straight toward your howitzer at an estimated range of 600 meters.

CARD 2

The first round fired by your section went over the tank. The tank has now turned and is moving from left to right in front of your position at a speed of 25 mph and at the initial range of 600 meters.

CARD 3

The second round fired by your section was short of the tank and on line. The tank has turned again and is now moving from right to left at a 45° angle going away from your position at a speed of 20 mph.

CARD 4

The tank was hit by your third round but was only partially disabled. You now desire to completely disable the tank and decide to fire on it using the ricochet technique.

Evaluation Checklist/Standards/Scoring

Each situation card will be worth a total of 22 points.

Each section should be evaluated on four separate situation cards, for a total of 88 possible points.

Each situation will be evaluated and penalties assessed as shown below.

STANDARD	PENALTY	MAXIMUM POSSIBLE POINTS CUT
The section chief issues correct and complete fire commands within 20 seconds of the receipt of each card, and section members announce correct commands.	-1 for each incorrect or omitted fire command or for each command that takes over 20 seconds to issue.	-6
The announced lead and range or elevation are set off.	-6 for any incorrect lead or range/elevation.	-6
All bubbles are centered when the howitzer is fired.	-2 for each bubble not level.	-4
The time from the last digit of range/elevation until the howitzer is fired is 10 seconds or less.	-1 for each second over 10.	-6

Section VII. EVALUATION PHASE V

During this phase, conducted as soon after phases II through IV as possible, the following actions are accomplished:

All section personnel will be thoroughly briefed on the detailed results of the evaluation.

Outstanding performances should be recognized and highlighted.

Weak areas should be critiqued in a constructive manner aimed at establishing specific tasks requiring further training emphasis.

All questions will be answered.

Section feedback should be encouraged in an effort to improve the content, organization, or administration of the evaluation.

APPENDIX D

GUNNER'S QUALIFICATION TEST

Section I. GENERAL

D-1. Purpose and Scope

a This appendix describes a test that may be given to determine the qualification of gunners. It evaluates the individual field artillery soldier in the performance of the principal duties of the gunner and in those specified duties of the chief of section and assistant gunner that the gunner may be called upon to perform. This test applies to all weapons and has the following purposes:

Primarily, to bolster the esprit and motivation of the soldier through recognition of individual proficiency. Clasps for the marksmanship badge (see AR 672-5-1) and/or locally produced certificates can be used to distinguish the well-trained field artillery soldier.

Additionally, to serve as a supplement to performance-oriented training. The tasks laid out in this appendix should be used as training vehicles, and as much time as possible should be devoted to controlled practice of a task. The soldier should practice each task under close supervision to acquire the degree of proficiency required by the standards stated in the test period. After the gunner's qualification test has been administered, those who meet the standards can be considered as qualified gunners and can proceed to another activity; those who do not should be critiqued on mistakes and continue to practice.

b. Since all tasks within this test are related directly to the tasks laid forth in the 13B soldier's manual (SM), each task has been referenced in parentheses to denote the appropriate SM task number. Questions on various tasks can be referred first to the soldier's manual, then, in turn, to the appropriate field or technical manual.

Note. The tasks of this test should *not* be used as a basis for determining the relative proficiency of batteries or higher units.

D-2. Standards of Precision

The examinee will be required to perform the tasks in accordance with the standards listed below.

a. Settings must be exact.

b. Bubbles in leveling vials must be centered exactly.

c. The vertical crosshair of the reticle on the panoramic telescope must be alined exactly on the left edge of the aiming post, on the 0 line of the collimator, or on exactly the same part of the designated aiming point each time the piece is laid.

d. The final motion of the traversing handwheel must always be from left to right.

e. The final motion of the elevating handwheel must always be in the direction of greater resistance.

f. Azimuth knobs must be rotated so as to approach the aiming point from left to right.

g. The appropriate deflection correction must be set on the gunner's aid.

D-3. Assistance

a. The examinee will not receive unauthorized assistance, but will be provided an assistant for a specific task. If the examinee fails any task because of the fault of the examiner or an assistant, that task will be disregarded and the examinee will be given another task of the same nature.

b. The time for any task will be the time from the last word of the command from the examiner to the last word of the appropriate report or the word "ready" from the examinee. The examinee may begin any task after the first word of the first command and should not be charged for any time used by the examiner.

D-4. Task Scoring

Scoring will be in accordance with the standards for each task. No credit will be given if any of the general standards of precision or the standards of a specific task

are not met. A **no go** awarded for any of the task standards will cause the task to be considered unsatisfactory, and 0 points will be awarded. If the examinee receives all **go** ratings for the standards, the score for the task will depend upon the speed of execution.

Section II. PREPARATION FOR TESTING

D-5. General

The piece will be prepared for action and the examinee posted at the proper position according to the task being conducted or as indicated in the conditions of the task. The examiner will insure that the examinee understands the requirements of each task and will require him to report **I AM READY** before each task.

D-6. Qualification Scores

Scores determining the qualification status of the gunner are as follows:

POINTS	CLASSIFICATION
90-100	Expert Gunner
80-89	Gunner First Class
70-79	Gunner Second Class

D-7. Equipment, Personnel, and Site Requirements

a. Successful administration of the test is enhanced by efficient organization of the testing site. The specific approach employed will depend upon the availability of equipment, space, and qualified examiner personnel. Should it be necessary to use only

one station, the following must be available:

(1) A weapon in position with complete section equipment (to include all boresighting materials).

(2) An aiming circle with field phone.

(3) A second weapon for reciprocal laying and checks.

(4) A chief examiner.

(5) An assistant examiner (two required for boresighting with testing target).

(6) At least one distant aiming point 1,500 meters from the cannon.

(7) Two direct fire targets 600 meters from the cannon and 50 meters apart.

b. Whenever possible, it is desirable to employ multiple stations in a round-robin setup. Such an approach provides the most efficient use of required equipment, particularly in tasks requiring the aiming circle or a second weapon. Additionally, each examinee is exposed to a given task on the same equipment and evaluated by the same examiner. One method of organizing such a testing site is depicted below.



DF TGT#1



DF TGT# 2



DAP# 1



A/C



**TASKS 13
& 14**



**TASKS 10,
11 & 12**



**TASKS 8
& 9**



**TASKS 4, 5,
6, 7**



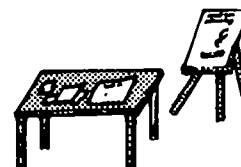
**TASKS 1,
2, 3**



**RECIPROCAL
CANNON
(PRACTICE WHEN FREE)**



DAP# 2



IN-BRIEF POINT

TEST OUTLINE

TASK NO.	SUBJECT	NO. OF ELEMENTS	POINTS	MAXIMUM CREDIT
1	Laying the Cannon for Initial Direction of Fire Using the Aiming Circle	1	4	4
2	Laying the Cannon for Initial Direction of Fire Using the M2 Compass	1	4	4
3	Laying the Cannon for Initial Direction of Fire Using a Distant Aiming Point	1	4	4
4	Laying Another Cannon Reciprocally	1	4	4
5	Conducting a Reciprocal Check	1	4	4
6	Alinement of Collimator	1	5	5
7	Alinement of Aiming Posts	1	5	5
8	Boresighting the Cannon (use only 2 of 4 methods)	2	5	10
9	Indirect Laying, Deflection Only	6	4	24
10	Direct Laying, Panoramic Telescope	4	4	16
11	Correcting for Displacement (Aiming Posts)	1	4	4
12	Correcting for Displacement (Collimator)	1	4	4
13	Laying for Quadrant with the Elevation Quadrant	1	4	4
14	Laying for Quadrant with the Gunner's Quadrant	2	4	8
TOTAL POINTS				100

RECOMMENDED GRADING SHEET

GUNNER'S TEST

GUNNER'S NAME _____ SECTION _____ DATE _____

SECTION CHIEF _____ EXAMINER _____

POINTS
POSSIBLE

POINTS
ACHIEVED

TASK 1 (Laying Using Aiming Circle)

4

1. Any **no go's** awarded?

Yes = 0 points

2. If all **go's** awarded:

Time _____ = _____ points

TASK 2 (Laying Using M2 Compass)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 3 (Laying Using DAP)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 4 (Laying Reciprocally)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 5 (Reciprocal Check)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 6 (Alinement of Collimator)	5	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 7 (Alinement of Aiming Posts)	5	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
<i>Note to examiner: Select only two elements of task 8 for evaluation.</i>		
TASK 8A (Boresight with Testing Target)	5	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 8B (Boresight with M140 Alinement Device)	5	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 8C (Boresight Using Standard Angle)	5	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 8D (Boresight Using a DAP)	5	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 9A (Indirect Laying, Command 1)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points

TASK 9B (Indirect Laying, Command 2)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 9C (Indirect Laying, Command 3)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 9D (Indirect Laying, Command 4)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 9E (Indirect Laying, Command 5)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 9F (Indirect Laying, Command 6)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 10A (Direct Laying, Command 1)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 10B (Direct Laying, Command 2)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 10C (Direct Laying, Command 3)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 10D (Direct Laying, Command 4)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 11 (Correcting for Displacement) (Aiming Posts)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points
TASK 12 (Correcting for Displacement) (Collimator)	4	
1. Any no go's awarded?		Yes = 0 points
2. If all go's awarded:		Time _____ = _____ points

TASK 13 (Laying for QE with Elevation Quadrant)

4

1. Any **no go's** awarded?

Yes = 0 points

2. If all **go's** awarded:

Time _____ = _____ points

TASK 14A (Laying for QE with Gunner's Quadrant) (Command 1)

4

1. Any **no go's** awarded?

Yes = 0 points

2. If all **go's** awarded:

Time _____ = _____ points

TASK 14B (Laying for QE with Gunner's Quadrant) (Command 2)

4

1. Any **no go's** awarded?

Yes = 0 points

2. If all **go's** awarded:

Time _____ = _____ points

TOTAL POINTS ACHIEVED _____**QUALIFICATION STATUS****(Circle one)**

Expert	1st Class	2d Class	Unqualified
100-90 points	89-80 points	79-70 points	69-0 points

Section III. GUNNER'S TEST**TASK 1:** Laying the cannon for initial direction of fire, using the aiming circle (061-13B-1038).**Conditions**

Examinee provided with a weapon in position with the tube within 100 mils of the azimuth of fire (no shift in trails or motor carriage will be made).

Wire communications with aiming circle will be provided. Aiming circle will be manned by assistant examiner.

Examinee will position himself as gunner.

The assistant examiner commands **NUMBER ONE, DEFLECTION** _____.

Evaluation Checklist

a. The examinee sets the announced deflection on the panoramic telescope and traverses the howitzer until his line of sight through the telescope is on the aiming circle.

b. He checks to insure that the bubbles are centered and announces **NUMBER ONE, READY FOR RECHECK.**

GO	NO GO

c. As additional deflections are announced by the assistant examiner, the examinee sets them off on the panoramic telescope and traverses the tube so that the vertical reticle of the panoramic telescope bisects the lens of the aiming circle.

d. The examinee follows correct procedures in completing the task.

e. The piece is properly laid with a difference of 0 mils. The gunner records the laid deflection on the gunner's reference card.

GO	NO GO

Scoring

Timing begins with the command DEFLECTION _____ from the aiming circle and ends with the announcement that the piece is laid.

TIME IN SECONDS

POINTS

45.0 or less

4

45.1 to 60.0

3

60.1 to 75.0

2

75.1 to 90.0

1

90.1 or more

0

TASK 2: Laying the cannon for initial direction of fire, using the M2 compass (061-13B-1038).

Conditions

Examinee provided with a weapon in position with the tube within 100 mils of the azimuth of fire (no shift of trails or motor carriage will be made).

Examinee will position himself as gunner.

The assistant examiner commands NUMBER ONE ADJUST, AIMING POINT THIS INSTRUMENT, DEFLECTION _____.

Evaluation Checklist

a. The examinee sets the announced deflection on the panoramic telescope and traverses the tube until his line of sight through the telescope is on the M2 compass.

b. He checks to insure the bubbles are level and centered and announces NUMBER ONE, AIMING POINT IDENTIFIED, DEFLECTION _____.

c. After the weapon is laid, the gunner records the laid deflection on the gunner's reference card.

d. The examinee follows correct procedures in performing the task.

GO	NO GO

Scoring

Timing begins with the command DEFLECTION _____ from the assistant examiner and ends with the announcement NUMBER ONE, AIMING POINT IDENTIFIED, DEFLECTION _____.

TIME IN SECONDS

POINTS

30.0 or less

4

30.1 to 40.0

3

40.1 to 50.0

2

50.1 or more

0

TASK 3: Laying the cannon for initial direction of fire, using a distant aiming point (DAP) (061-13B-1038).

Conditions

Examinee provided with a weapon in position with the tube within 100 mils of the azimuth of fire (no shift in trails or motor carriage will be made).

Examinee will be shown a distant aiming point (DAP).

Examinee will position himself as gunner.

Examiner commands NUMBER ONE ADJUST, AIMING POINT (so-and-so) (location), DEFLECTION_____.

Evaluation Checklist

- a. The examinee identifies the DAP and sets off the deflection on the azimuth counter/scale.
- b. He traverses the tube until the vertical reticle of his pantel is sighted on the DAP and all bubbles are centered and level.
- c. Examinee announces NUMBER ONE, AIMING POINT IDENTIFIED, DEFLECTION_____, then records the laid deflection and establishes his aiming points.
- d. The examinee follows correct procedures in performing the task.
- e. The piece is properly laid and deflection is recorded on the gunner's reference card.

GO	NO GO

Scoring

Timing begins when the DAP has been identified and ends with the announcement NUMBER ONE, AIMING POINT IDENTIFIED, DEFLECTION_____.

TIME IN SECONDS

POINTS

30.0 or less
30.1 to 40.0
40.1 or more

4
2
0

TASK 4: Laying another cannon reciprocally (061-13B-1038).

Conditions

Examinee will be provided a weapon in position and already laid for initial direction.

Assistant examiner will act as gunner on the other weapon, positioned with the tube within 100 mils of the azimuth of fire.

Examinee will position himself as gunner.

Evaluation Checklist

- a. The examinee refers his panoramic telescope to the piece to be laid.
- b. The examinee commands, NUMBER TWO, ADJUST, AIMING POINT THIS INSTRUMENT.

GO	NO GO

c. Upon hearing AIMING POINT IDENTIFIED from the other weapon, the examinee reads the deflection from the azimuth counter (M100-series) or non-slipping azimuth scale (M12-series) of his panoramic telescope, then commands NUMBER TWO, DEFLECTION _____. (If the weapons are equipped with M100-series sights, the examinee must either add 3,200 mils to his azimuth counter reading or subtract 3,200 mils from it. If the piece to which he refers is on his left, he adds; if on his right, he subtracts.)

d. The examinee continues to read deflections to the adjacent piece until its gunner reports 0 MILS. The examinee then commands, NUMBER TWO IS LAID.

e. The examinee follows correct procedures in completing the task.

GO	NO GO

Scoring

Timing begins with the command NUMBER TWO, ADJUST and ends with NUMBER TWO IS LAID.

TIME IN SECONDS

POINTS

50 or less

4

More than 50

0

TASK 5: Verifying direction of fire with a reciprocal check (061-13B-1051) (061-13B-1040).

Conditions

Examinee is given two weapons laid on the same azimuth; the second weapon's gunner is the assistant examiner.

Evaluation Checklist

a. The examinee insures line of sight exists and refers to adjacent piece.

b. Examinee properly reads the deflection on the azimuth counter (M100-series) or nonslipping azimuth scale (M12-series).

c. Examinee follows correct procedures in performing the task.

d. Proper deflection difference (if any) is determined and forwarded to the executive officer or chief of firing battery (examiner).

GO	NO GO

Scoring

TIME IN SECONDS

POINTS

15 or less

4

More than 15

0

TASK 6: Alinement of collimator (061-13B-1012).

Conditions

The piece will have been laid on the azimuth of fire.

An assistant examiner will be provided with an operable collimator.

Examiner will announce the prescribed deflection.

Examinee will position himself as gunner.

Evaluation Checklist

a. Using the azimuth counter knob, the examinee rotates the head of the panoramic telescope to a prescribed deflection, insuring that bubbles are centered and level.

b. He directs the assistant, using proper hand and arm signals, to emplace the collimator so 3 numbers or 11 graduations can be seen in the reticle pattern.

c. The examinee directs the assistant to aline the collimator with the panoramic telescope by use of the cylindrical cross-level vial and the azimuth and elevation clamping knobs so that there is no initial displacement.

d. The examinee follows correct procedures in performing the task.

GO	NO GO

Scoring**TIME IN SECONDS**

120 or less

More than 120

POINTS

5

0

TASK 7: Alinement of aiming posts (061-13B-1012).

Conditions

The piece will have been laid on the azimuth of fire.

An assistant examiner will be provided with two aiming posts.

The examiner will announce the prescribed deflection or general direction for emplacing the aiming posts.

The aiming posts will have been positioned at 50 and 100 meters prior to the start of the test.

The examinee will position himself as gunner.

Evaluation Checklist

a. The examinee turns the pantel to the deflection at which the aiming posts will be emplaced and insures that cross-level and pitch-level vial bubbles are centered and that the gunner's aid reads 0.

b. Examinee then uses hand and arm signals to correctly emplace the aiming posts, insuring that the far post is set first, then the near post.

c. M100-series sight: Records deflection from azimuth scale and resets to 3200 with the reset counter knob.

d. M12-series sight: Records deflection from nonslipping azimuth and micrometer scales. Releases slipping azimuth scale locking screw and slips scale to prescribed referred deflection value in hundreds. Unlocks slipping micrometer scale locking nut and slips micrometer scale to 0. Tightens both screws and closes the door covering the nonslipping azimuth scale.

e. Examinee follows correct procedures in performing the task.

GO	NO GO

Scoring**TIME IN SECONDS**

120 or less
More than 120

POINTS

5
0

TASK 8A: Boresighting the cannon using the testing target (061-13B-1036).

Conditions

The piece will be prepared for action.

The trunnions will be level.

The examinee will be provided assistants as necessary to position a testing target on a stand in front of the weapon.

The examinee will be provided a serviceable gunner's quadrant (end-for-end test and micrometer knob test have been performed and the examinee knows the correction), a breech boresight, a muzzle boresight, and necessary screwdrivers and wrenches.

Evaluation Checklist

a. Using the gunner's quadrant, the examinee levels the tube and insures that the pantel is properly mounted.

b. Centers the elevation and cross-level vials on the panoramic telescope mount and the elevation quadrant (if applicable), and insures that all numerical counters on the elevation quadrant read 0 (on the M12-series sight, the elevation reading on the panoramic telescope must be 0).

c. Using the muzzle and breech boresight and the testing target with stand, the examinee has assistants aline the appropriate diagram of the testing target with the line of sight through the tube.

d. The tube should not have been moved by the examinee.

e. On an M12-series sight, the examinee sets the azimuth scale to 0 mils. Using the elevation knob of the sight and the tangent screws, he adjusts the panoramic telescope reticle precisely on the left aiming diagram of the testing target.

f. On an M100-series sight the examinee adjusts the azimuth and elevation knobs on the panoramic telescope to lay the reticle precisely on the left aiming diagram of the testing target. The azimuth counter should read 3,200 mils. If it does not, he depresses and turns the boresight adjustment shaft until 3200 appears in the counter window.

g. The bubbles of the panoramic telescope mount must be centered.

h. The examinee follows correct procedures in performing the task.

i. The weapon is in boresight at the completion of the task.

GO	NO GO

Scoring**TIME IN MINUTES**

3 or less
More than 3

POINTS

5
0

TASK 8B: Boresight the cannon with the M140 alinement device (061-13B-1026).

Conditions

The examinee will be given a serviceable M140 alinement device installed on the weapon with the tube leveled.

Evaluation Checklist

- a. The examinee levels the cross-level and longitudinal-level vials.
- b. Alines the pantel crosshairs with the crosshairs of the alinement device, using the azimuth and elevation knobs.
- c. Checks the reading on the azimuth counter to insure it is within one-half mil of the proper reading. If it is not, removes the boresight adjustment shaft cover.
- d. Adjusts the azimuth counter reading by depressing the boresight adjustment shaft with a screwdriver and rotating the shaft until the proper reading is indicated on the azimuth counter.
- e. Checks that the sight picture has not changed after the adjustment.
- f. Follows correct procedures in boresighting the cannon so that the line of sight of the pantel is alined with the crosshairs of the M140 within one-half mil.
- g. The azimuth counter indicates the proper reading.

GO	NO GO

Scoring

TIME IN MINUTES

POINTS

One or less
More than one

5
0

TASK 8C: Boresighting the cannon using the standard angle method (061-13B-1033).

Conditions

Examinee will be given a cannon with trunnions level within 90 mils, the standard angle deflection and elevation, scribed lines predetermined during fire control alinement tests, a bright pin attached to the left muzzle witness mark, a pantel with parallax shield, and screwdrivers needed for boresighting.

Evaluation Checklist

- a. The examinee verifies that the recoiling parts are in correct position by checking the scribed line on the cradle (M101A1, M110/M110A1, and M107) or by measuring the distance from muzzle to wiper M114A1/M114A2).
- b. Installs the parallax shield.
- c. Alines red scribed lines on the panoramic telescope mount.
- d. M114A1(A2):
 - (1) Sets the standard angle elevation with the gunner's quadrant.
 - (2) Sets the standard angle deflection on the azimuth scale.

GO	NO GO

- (3) Turns the tangent screws to align on the pin if not properly aligned.
 - (4) Turns the elevation knob on the panel to align the horizontal line on the pin. Adjusts the zero of the elevation scale by loosening the three small screws, then retightens screws.
 - (5) Verifies that correct deflection and elevation are on the scales and that the sight picture is correct.
- e. M101A1, M110/M110A1, and M107:
- (1) Elevates tube to correct standard angle elevation, using the gunner's quadrant.
 - (2) Sets the standard angle deflection on the azimuth scale.
 - (3) Aligns the vertical hairline on the pin by turning the tangent screws (M101A1) or the azimuth knob (M110/M110A1 and M107).
 - (4) Uses the boresight adjustment shaft to reset the azimuth counter to the correct standard angle deflection (M110/M110A1 and M107) only.
 - (5) Aligns the horizontal hairline on the pin by turning the elevation knob on the panel. Adjusts the zero of the elevation scale by loosening the three small screws, then retightens screws.
 - (6) Verifies that the deflection on the panoramic telescope is correct, the sight picture is correct, and tube is on the standard angle elevation.
- f. The examinee follows correct procedures in performing the task.
- g. The weapon is boresighted to an accuracy of 0 mils.

[illegible]

Scoring

TIME IN MINUTES	POINTS
3 or less	5
More than 3	0

TASK 8D: Boresight the cannon using a distant aiming point (061-13B-1029).

Conditions

The examinee will be given a well-defined aiming point at least 1,500 meters distant, a weapon mounted with boresight strings and disk, trunnions level within 90 mils, an assistant to aline the tube on the DAP (M101A1 and M114A1/M114A2), and the tube at zero elevation (M101A1 and ★M114A1/M114A2) or the tube alined on the DAP (M102, M109/M109A1/A2/A3, M110/M110A1/A2, and M107).

Evaluation Checklist

- a. In boresighting the M101A1, the examinee—
 - (1) With the tube at zero elevation, insures that bubbles are centered and all scales are set on zero.
 - (2) Has the assistant aline the tube on the DAP. Sets the azimuth and micrometer scales of the pantel to zero.

GO	NO GO

(3) Aligns the crosshairs of the pantel with the DAP by adjusting the vertical reticle with the tangent screws and the horizontal reticle with the telescope elevating knob.

(4) Slips the elevation scale to zero by loosening the three small screws on the elevating knob.

(5) Tightens the screws on the elevation knob. Tightens the tangent locking screws.

(6) Verifies sight picture.

b. Boresighting the M114A1(A2), the examinee—

(1) Insures that all bubbles are centered, adjusts the actuating arm if necessary.

(2) Sets all scales and indexes to zero.

(3) Has the tube boresight crosshairs alined on the DAP.

(4) Aligns the crosshairs of the pantel with the DAP by adjusting the vertical crosshairs with tangent screws and the horizontal crosshairs with the elevating knob.

(5) Slips the elevation scale to zero by loosening the three small screws on the elevation knob.

(6) Tightens the screws on the elevation knob and the tangent locking screws.

(7) Verifies sight picture.

★ c. Boresighting the M102 and M109/M109A1/A2/A3, the examinee—

(1) Checks bubbles to insure that they are centered.

(2) Zeroes the gunner's aid.

(3) Alines telescope reticle on the DAP using azimuth and elevating knobs.

(4) The azimuth counter should read 3200. If not, he depresses the boresight adjustment shaft with a small screwdriver until 3200 appears in the azimuth counter.

(5) Rechecks sight picture.

★ *d. Boresighting the M110/M110A1/A2 or M107, the examinee—*

(1) Centers the bubbles on the telescope mount.

(2) Zeroes the gunner's aid.

(3) Aligns the pantel reticle crosshairs on the DAP with the azimuth and elevation knobs.

(4) Checks the azimuth counter on the panel. If it does not read 3200, depresses the boresight adjustment shaft with a small screwdriver and turns it until 3200 appears in the window.

[illegible]

(5) Aligns the horizontal hairline on the DAP with the elevation knob. Slips the elevation scale to zero by loosening the three small screws.

(6) Rechecks sight picture.

e. The examinee follows correct procedures in boresighting the weapon.

f. The weapon is boresighted so that the line of sight of the pantel is aligned within one-half mil of the axis of the tube.

GO	NO GO

Scoring

TIME IN MINUTES

3 or less

More than 3

POINTS

5

0

TASK 9: Indirect laying, deflection only (061-13B-1039).

Conditions

A weapon will be prepared for action, and aiming posts or a collimator will be set out.

The commands will not necessitate movement of the motor carriage or a shifting of trails.

A suitable alternate aiming point will be identified to the examinee.

Actions taken as a result of each command will be graded separately.

The piece will be laid with the correct settings at the conclusion of each test before the examinee proceeds to the next test.

The examiner will designate the section number of the piece to be used and will announce, when applicable, special corrections in deflection to be applied by the examinee.

The examinee will be posted as the gunner.

Evaluation Checklist 9A

GO	NO GO

Command Number 1: SPECIAL CORRECTIONS, DEFLECTION 3290, NUMBER ONE, LEFT 7. (For M101A1, use DEFLECTION 2890; for M114A1(A2) use DEFLECTION 2490.)

a. The examinee applies special corrections to the pantel to an accuracy of 0 mils and sets off the deflection.

b. Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.

c. Traverses the tube until the vertical line on the panoramic telescope reticle is on the left edge of the aiming post or until the proper collimator sight picture appears.

d. The examinee then—

(1) Checks centering of the bubbles.

(2) Re-lays the weapon if necessary.

(3) Announces READY when the action is completed.

e. Examinee follows correct procedures in laying the cannon for deflection.

f. Piece is properly laid on prescribed deflection to include any special corrections.

GO	NO GO

Scoring 9A

Timing starts when fire mission deflection is announced and ends with examinee's announcement of READY.

TIME IN SECONDS

POINTS

13.0 or less

4

13.1 to 14.0

3

14.1 to 15.0

2

15.1 or more

0

Evaluation Checklist 9B

GO	NO GO

Command number 2: DEFLECTION 3050. (For M101A1, use DEFLECTION 2650; for M114A1(A2), DEFLECTION 2250.)

- a.* The examinee sets the deflection.
- b.* Leaves the corrections on the gunner's aid.
- c.* Lays on the aiming posts or collimator.
- d.* Checks the centering of the bubbles.
- e.* Announces READY when the action is completed.
- f.* Examinee follows correct procedures in laying the weapon for prescribed deflection.
- g.* Piece is properly laid on prescribed deflection.

Scoring 9B

Time begins with fire command and ends with the announcement of READY.

TIME IN SECONDS

POINTS

8.0 or less

4

8.1 to 9.0

3

9.1 to 10.0

2

10.1 or more

0

Evaluation Checklist 9C

Command Number 3: NUMBER ONE, RIGHT 4.

- ★ *a.* The examinee applies right 4 to the gunner's aid (R4 should be on the gunner's aid).
- b.* Lays on the aiming posts or collimator.
- c.* Checks the centering of the bubbles.
- d.* Re-lays the weapon if necessary.
- e.* Announces READY when the action is completed.
- f.* Examinee has properly laid the piece for prescribed correction.

GO	NO GO

Scoring 9C

Time begins with announcement of correction and ends when examinee announces READY.

TIME IN SECONDS**POINTS**

8.0 or less	4
8.1 to 9.0	3
9.1 to 10.0	2
10.1 or more	0

UNGRADED: Examiner commands END OF MISSION. The examinee sets the gunner's aid to 0.

Evaluation Checklist 9D

	GO	NO GO
Command Number 4: AIMING POINT, CHURCH STEEPLE (or some other distant aiming point), REFER. (061-13B-1040)		
a. The examinee turns the panoramic telescope to the church steeple and aligns the reticle pattern on a straight vertical portion of the steeple.		
b. M100-series sight: The examinee uncovers the azimuth counter, reads the deflection, and announces NUMBER ONE, DEFLECTION _____.		
c. M12-series-sight: The examinee reads the deflection on the nonslipping azimuth scale and azimuth micrometer scale and announces NUMBER ONE, DEFLECTION _____.		
d. Examinee properly performs the procedure for completing the command.		

Scoring 9D

Timing begins with command and ends when examinee announces deflection.

TIME IN SECONDS**POINTS**

8.0 or less	4
8.1 to 9.0	3
9.1 to 10.0	2
10.1 or more	0

Evaluation Checklist 9E

	GO	NO GO
Command Number 5: DEFLECTION 3200, REFER. (For M101A1, use DEFLECTION 2800; for M114A1(A2), use DEFLECTION 2400.)		
a. M100-series sight: The examinee pushes in and rotates the reset counter knob until the reset counter reads 3200.		
b. M12-series sight: The examinee loosens the azimuth slipping scale, rotates it to 2800 for the M101A1 or 2400 for the M114A1(A2), slips the azimuth micrometer scale to zero, then tightens the slipping scale. The door to the nonslipping azimuth scale is closed.		
c. The examinee calls NUMBER ONE, DEFLECTION 3200 (for M101A1, 2800; for M114A1, 2400) and steps clear.		
d. Examinee properly performs the procedures for the given command.		

Scoring 9E

Timing begins with command and ends when examinee announces deflection.

TIME IN SECONDS	POINTS
13.0 or less	4
13.1 to 14.0	3
14.1 to 15.0	2
15.1 or more	0

Evaluation Checklist 9F

	GO	NO GO
Command Number 6: DEFLECTION 3129. (For M101A1, use DEFLECTION 2729; for M114A1(A2), DEFLECTION 2329.)		
a. The examinee sets the deflection on the reset counter or slipping azimuth scale.		
b. Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.		
c. Traverses the tube until the vertical line of the panoramic telescope reticle is on the same straight vertical portion of the distant aiming point that the examinee referred to after command number 4.		
d. Checks the centering of the bubbles.		
e. Re-lays the weapon if necessary.		
f. Announces READY when the action is completed.		
g. Examinee properly lays the piece.		

Scoring 9F

Timing begins with command and ends when examinee announces READY.

TIME IN SECONDS	POINTS
8.0 or less	4
8.1 to 9.0	3
9.1 to 10.0	2
10.1 or more	0

TASK 10: Direct laying, panoramic telescope (061-13B-1025).

Conditions

Two stationary targets will be placed approximately 600 meters from the weapon. The targets should be separated by at least 50 meters.

The azimuth counter will be set to 3,200 mils (or, on the M12-series sights, the azimuth and micrometer scales will be set to 0) and the gunner's aid will be set to 0.

The weapon will be oriented so that a 100-mil shift is required but the motor carriage or trails will not have to be shifted in order to engage the stationary targets.

The examinee will be posted as the gunner. The two-man, two-sight system will be used (two-man, one-sight for the M114A1(A2) howitzer).

An assistant will be provided to lay the piece for range (quadrant on the M114A1/M114A2) and to center the cross-level vials.

Evaluation Checklist 10A

GO	NO GO

Command Number 1: TARGET THAT TANK, LEAD RIGHT 10, RANGE 800. (For the M114A1(A2) replace RANGE 800 with QUADRANT 16.)

a. M100-series sight: Examinee sets the lead on the azimuth counter, traverses the tube until the vertical reticle is on the center of the target mass, centers the cross-level bubble, steps clear, and commands FIRE.

b. M12-series sight: Examinee traverses the tube until the announced lead is established (the vertical reticle is in proper relationship to the target), steps clear, and commands FIRE.

c. Examinee follows correct procedures in performing the task.

Note. The above checks are based upon central laying with the M100-series sight and reticle laying with the M12-series. Although these are the preferred methods for each, either method may be used with both sights.

Scoring 10A

Timing begins when fire command is given and ends when examinee commands FIRE.

TIME IN SECONDS**POINTS**

5.0 or less

4

5.1 to 6.0

3

6.1 to 7.0

2

7.1 or more

0

Evaluation Checklist 10B

GO	NO GO

Command Number 2: RIGHT 10, DROP 200. (For M114A1(A2), change DROP 200 to DROP 7.)

a. M100-series sight: Examinee sets off the change in lead by using the click sight, traverses the tube until the vertical reticle is on the center of the target, steps clear, and commands FIRE.

b. M12-series sight: Examinee traverses the tube until the change in lead has been taken up with the vertical reticle, steps clear, and commands FIRE (for the M114A1, after the assistant announces SET).

c. Examinee follows correct procedures in performing the task.

Scoring 10B

Timing begins when fire command is given and ends when examinee commands FIRE.

TIME IN SECONDS**POINTS**

5.0 or less

4

5.1 to 6.0

3

6.1 to 7.0

2

7.1 or more

0

Evaluation Checklist 10C

(For commands 3 and 4, use the second of the two targets.)

	GO	NO GO
Command Number 3: TARGET THAT TANK, LEAD LEFT 5, RANGE 600. (For the M114A1(A2), replace RANGE 600 with QUADRANT 9.)		
a. M100-series sight: Same as for command 1.		
b. M12-series sight: Same as for command 1.		

Scoring 10C**TIME IN SECONDS****POINTS**

5.0 or less	4
5.1 to 6.0	3
6.1 to 7.0	2
7.1 or more	0

Evaluation Checklist 10D

	GO	NO GO
Command Number 4: LEFT 10, ADD 200. (For M114A1(A2), change ADD 200 to ADD 7.)		
a. M100-series sight: Same as for command 2.		
b. M12-series sight: Same as for command 2.		

Scoring 10D**TIME IN SECONDS****POINTS**

5.0 or less	4
5.1 to 6.0	3
6.1 to 7.0	2
7.1 or more	0

TASK 11: Correcting for displacement with aiming posts (061-13B-1039).

Conditions

A weapon will be prepared for action.

Aiming posts will be emplaced at the prescribed deflection; however, the far aiming posts will be moved perpendicular to the line of sight through the panoramic telescope so that a 5- to 10-mil displacement with the near aiming post will occur.

The weapon will be oriented so that the motor carriage or the trails will not have to be shifted.

The examiner will command DEFLECTION 3160. (For M101A1, use DEFLECTION 2760; for M114A1(A2), use DEFLECTION 2360.)

Evaluation Checklist

	GO	NO GO
a. The examinee sets the announced deflection on the panoramic telescope.		
b. Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.		
c. Traverses the tube until the far aiming post appears midway between the near aiming post and the vertical crosshair of the telescope.		
d. Checks the centering of the bubbles.		

- e. Re-lays the weapon if necessary.
- f. Announces READY when action is completed.
- g. Examinee follows the correct procedure in allowing for displaced aiming posts.
- h. Piece is laid on prescribed deflection.

GO	NO GO

Scoring

Timing begins with announcement of deflection and ends when examinee announces READY.

TIME IN SECONDS

POINTS

8.0 or less	4
8.1 or 9.0	3
9.1 to 10.0	2
10.1 or more	0

TASK 12: Correcting for displacement with the collimator (061-13B-1039).

Conditions

A weapon will be prepared for action.

A collimator will be emplaced at the prescribed deflection; however, the collimator will be rotated slightly so that a 5- to 10-mil displacement occurs.

The examiner will command DEFLECTION 3345. (For M101A1, use DEFLECTION 2945; for M114A1(A2), use DEFLECTION 2545.)

Evaluation Checklist

- a. The examinee sets the announced deflection on the panoramic telescope.
- b. Centers the cross- and pitch-level bubbles on the panoramic telescope mount.
- c. Traverses the tube until the proper sight picture for the actual displacement is visible in the panoramic telescope.
- d. Checks the centering of the bubbles.
- e. Re-lays the weapon if necessary.
- f. Announces READY when action is completed.
- g. Examinee follows correct procedures in laying the piece with a displaced collimator.

GO	NO GO

Scoring

Timing begins with announcement of deflection and ends when examinee announces READY.

TIME IN SECONDS

POINTS

8.0 or less	4
8.1 to 9.0	3
9.1 to 10.0	2
10.0 or more	0

TASK 13: Laying for quadrant with the elevation quadrant (061-13B-1018).**Conditions**

The weapon will be prepared for action.

The examinee will be posted as the assistant gunner (gunner on the M114A1/M114A2).

The setting on the elevation scale will be within 40 mils of the announced quadrant.

The examiner commands QUADRANT 375.

Evaluation Checklist

- a. Sets the announced quadrant on the elevation counter.
- b. Centers the cross-level and elevation bubbles by elevating or depressing the tube as necessary.
- c. Announces READY when action is completed.
- d. Examinee follows correct procedures in performing the task.

GO	NO GO

Scoring

Timing begins when quadrant is announced and ends when examinee announces READY.

TIME IN SECONDS**POINTS**

6.0 or less

4

6.1 to 7.0

3

7.1 to 8.0

2

8.1 or more

0

TASK 14: Laying for quadrant with the gunner's quadrant (061-13B-1049).**Conditions**

The weapon will be prepared for action.

The examinee will be posted to the left of the breech or at the appropriate mount.

Prior to each command, the tube will be elevated to within 40 mils of the announced quadrant.

Before each command, the examinee will be provided with a tested gunner's quadrant set at 0.

An assistant will elevate or depress the tube at the examinee's direction.

Evaluation Checklist 14A

Command Number 1: QUADRANT 219.

- a. The examinee sets the announced quadrant on the gunner's quadrant.
- b. Sets the gunner's quadrant on the breech ring or appropriate sight mount so that the words "line of fire" are at the bottom of the quadrant and the arrow points toward the muzzle.
- c. Directs the assistant to elevate or depress the tube until the quadrant bubble is centered.
- d. Announces READY when the action is completed.

GO	NO GO

Scoring 14A

Timing begins with the quadrant command and ends with the examinee's announcing READY.

TIME IN SECONDS	POINTS
20.0 or less	4
20.1 to 35.9	3
36.0 to 44.9	2
45.0 or more	0

Elevation Checklist 14B

Command Number 2: QUADRANT 1037.

- a. The examinee sets the announced quadrant on the gunner's quadrant.
- b. Sets the gunner's quadrant on the breech ring or appropriate sight mount so that the words "lines of fire" are at the bottom of the quadrant and the arrow points toward the muzzle.
- c. Directs the assistant to elevate or depress the tube until the quadrant bubble is centered.
- d. Announces READY when the action is completed.

GO	NO GO

Scoring 14B

Timing begins with the quadrant command and ends with the examinee's announcing READY.

TIME IN SECONDS	POINTS
20.0 or less	4
20.1 to 35.9	3
36.0 to 44.9	2
45.0 or more	0

APPENDIX E

TESTS FOR THE QUALIFICATION OF SAFETY PERSONNEL

E-1. Purpose and Scope

This appendix is a series of tests designed to be used by the commander as a guide in developing a program that fully qualifies all personnel involved in firing. The commander may use these tests modified as required to meet local requirements, to determine the level and knowledge of selected personnel concerning safety regulations and procedures, and to determine specific areas that require refresher or remedial training.

E-2. Format

Test I is designed for those personnel not ordinarily tasked to compute safety data (e.g., the howitzer section chief and the chief of firing battery and the gunnery sergeant). Test II is designed for all officers and any other personnel who may be responsible for the computation of safety data. At the discretion of the examiner, Test I may also be given with Test II.

E-3. Test Administration

a. Examinees should be allowed approximately 1 week to prepare for the examination. During this period, they should have access to the following references:

- (1) AR 385-63.
- ★ (2) FM 6-50 with change 1.
- (3) Local range regulations, SOP's, etc. pertaining to safety.
- (4) Weapon technical and field manuals.

b. The following should be provided by the examiner for use by the examinee for part 4, test II, ONLY:

- (1) Applicable tabular and graphical firing tables.
- (2) Graphical site table.
- ★ (3) FM 6-50 with change 1.
- (4) AR 385-63.
- (5) One copy of local range regulations.

E-4. Grading

This grading procedure is a recommended method of weighting this examination. Test I is valued at 55 raw points. Tests I and II together are valued at 200 raw points.

TEST I

Part	Cuts per problem	Total weight
1. True and false	1 point each	15
2. Multiple choice	2 points each	20
3. Completion	2 points each	20

TEST II

Part	Cuts per problem	Total weight
1. True and false	1 point each	10
2. Multiple choice	2 points each	10
3. Completion	2 points each	20
4. Performance:		15
	26	25
	27	25
	28	20
	29	10
	30	10
	31	

Note. Mathematical errors and expression errors should be assessed a cut of 1 point each.

TEST I**Part 1. True and False**

1. _____ Each section chief must be informed of the minimum and maximum quadrants and the left and right deflection limits.
2. _____ It is safe to fire a projectile without a fuze.
3. _____ In direct fire, the chief of section must insure that minimum elevation limits are not violated.
4. _____ During heavy rain, the M514 fuze should not be fired.
5. _____ The chief of section will verify the serviceability of ammunition.
6. _____ Chemical and high-explosive projectiles can be stored together.
7. _____ Projectiles (and fuzes) that have been removed from a cannon by means of extraction should be fired on the next mission.
8. _____ Time fuzes previously set but not fired must be reset to safe.
9. _____ If the left deflection limit is 3650 mils, it is safe to fire a round at deflection 3700.

10. _____ The maximum and minimum quadrants do not change even if the charge or type of ammunition changes.
11. _____ When the firing point changes, so does the safety diagram.
12. _____ Once a howitzer is initially laid for direction with the aiming circle, it should never be traversed prior to emplacement of the collimator and aiming posts.
13. _____ A registration will cause the deflection limits, minimum time, and maximum and minimum quadrants of the safety diagram to change.
14. _____ Before firing a round, the chief of section must insure that the correct number and type of remaining charge increments are held up at the rear of the piece.
15. _____ The chief of section has final responsibility for the safety of the crew and the settings on his weapon prior to the command FIRE.

Part 2. Multiple Choice

16. Who is responsible for insuring that the proper time is set on a fuze before a round is loaded into a howitzer?
 - a. Chief of firing battery.
 - b. Executive officer.
 - c. Number 1 cannoneer.
 - d. Safety officer.
17. Who are the individuals specifically responsible for safety in service practice?
 - a. Range officer, OIC, safety officer, chief of section, and FDC.
 - b. Executive officer, safety officer, and battery commander.
 - c. Executive officer, safety officer, unit commander, and chief of section.
 - d. Executive officer, chief of firing battery, and safety officer.
18. What is the proper fuze setting to cause the M564 MTSQ fuze to function on impact?
 - a. 90.0 seconds.
 - b. Safe.
 - c. 100.0.
 - d. PD.
19. When the end-for-end test of the gunner's quadrant (M1 or M1A1) is performed, the maximum allowable error is plus or minus—
 - a. 4 mils.
 - b. 0.4 mil.
 - c. 1 mil.
 - d. 0.1 mil.
20. The proper command for verifying the lay of number 1 howitzer is—
 - a. NUMBER 1, AIMING POINT THIS INSTRUMENT, REFER.
 - b. NUMBER 1, REFERRED DEFLECTION THIS INSTRUMENT.
 - c. NUMBER 1, ADJUST.
 - d. NUMBER 1, ADJUST, AIMING POINT THIS INSTRUMENT.

21. Ammunition will NOT be fired if—
- it is over 6 months old.
 - the powder temperature is not known.
 - the lot number is not known.
 - it is more than 1 year old.
22. Which of the following best describes the use of a safety diagram?
- To check the fire commands against right and left deflection limits only.
 - To compare the announced fire commands against the safety limit data.
 - To graphically check the impact area against the range limits.
 - To compare the announced fire commands with the minimum range limits.
23. Which of the following constitutes an unsafe act?
- Failure to swab the powder chamber after each round.
 - Failure of the chief of section to check the gunner's sight picture prior to firing each round.
 - Failure of the chief of section to announce ON THE WAY.
 - Failure of the gunner to announce READY.
24. Who is authorized to announce CHECK FIRING?
- Executive officer only.
 - Safety officer only.
 - Chief of section or gunnery sergeant only.
 - Anyone noticing an unsafe condition.
25. How long may a round remain chambered in a hot tube before it should be fired or removed from the weapon?
- 1 minute.
 - 2 minutes.
 - 5 minutes.
 - 10 minutes.

Part 3. Completion

26. How are white phosphorus projectiles stored? Explain why.

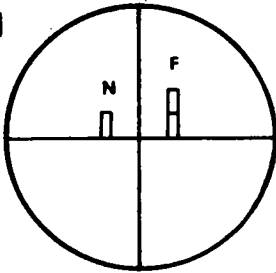
27. If a VT fuze does not seat properly in the fuze well, what actions should be taken?

28. Describe the method for placing out safety stakes.

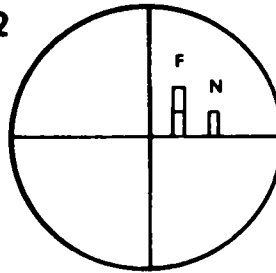
29. Which of the following diagrams illustrate correct sight pictures? Indicate your answer by placing an X in the appropriate spaces provided below.

- a. (1) _____ (2) _____ (3) _____
 b. (1) _____ (2) _____ (3) _____ (4) _____

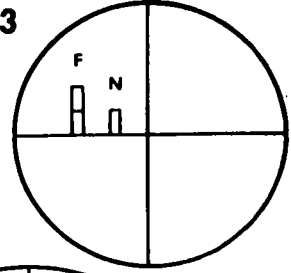
a. 1



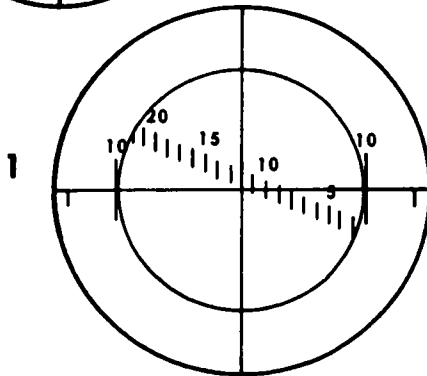
2



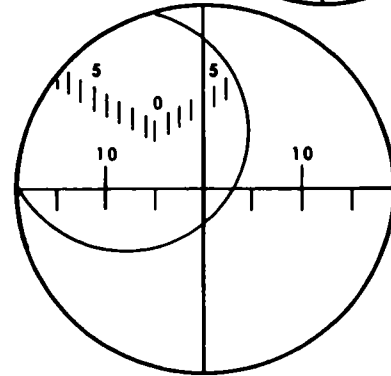
3



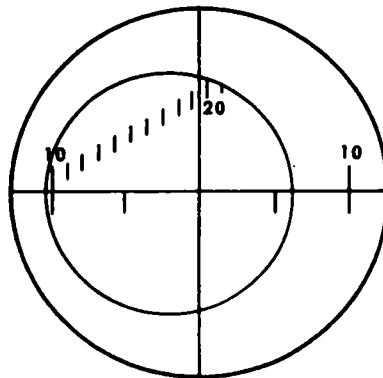
b. 1



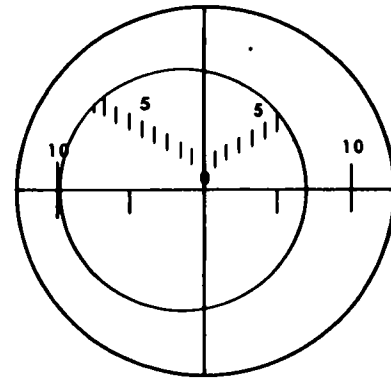
2



3



4



★30. List the actions taken in the event of a misfire on an M109/M109A1/A2/A3 howitzer (cold tube, charges 2 through 8).

Note. Requirements 31 through 33 are based on the safety T diagram shown below, which was computed for charge 4.

Max QE	417		
Deflection limits	3685	3315	2900
Min QE	209		177
Min safe FS M564	12.6		10.7
Min safe FS M514	19.0		17.0
Min QE (Ti & VT)	314		282

State whether the following data are safe or unsafe to fire; if unsafe, state why.

31. Lot XY, chg 4, fz quick, df 3695, QE 347.

32. Lot XY, chg 4, fz ti, 12.2, df 3472, QE 253.

33. Lot XY, chg 4, fz VT, 17.0, df 3515, QE 315.

★34. List the action taken in the event of a misfire on an M109/M109A1/A2/A3 howitzer (hot tube, charge 3).

35. Describe the method for measuring the greatest angle of site to a crest in front of the howitzer and list the five methods of determining piece-to-crest range.

SOLUTION I

Part 1. True and False

- | | | |
|----------|-----------|----------|
| 1. True | 6. False | 11. True |
| 2. False | 7. False | 12. True |
| 3. True | 8. True | 13. True |
| 4. True | 9. False | 14. True |
| 5. True | 10. False | 15. True |

Part 2. Multiple Choice

- | | |
|-------|-------|
| 16. d | 21. c |
| 17. c | 22. b |
| 18. a | 23. a |
| 19. b | 24. d |
| 20. a | 25. c |

Part 3. Completion

26. How are white phosphorus projectiles stored? Explain why.

They are stored with their bases down and away from other ammunition to prevent improper settling of the projectile filler.

27. If a VT fuze does not seat properly in the fuze well, what actions should be taken?

The fuze should be removed. Check the round to see if the supplementary charge is still in the fuze well. If it is, remove it, and install the fuze. If it still doesn't seat properly, remove it and turn it in to the ammunition section.

28. The method for placing out safety stakes is as follows:

Set on the sight, in turn, the left, intermediate, and right deflection limits determined from the safety card and take up a proper sight picture on the aiming point. Sight through the breech end of the tube and, sighting along the left edge of the tube for the left limit and the right edge of the tube for the right limit, aline the safety stakes.

29. Which of the following sight diagrams illustrate correct sight pictures? Indicate your answer by placing an X in the appropriate spaces below.

a. (2)

b. (4)

★30. List the actions taken in the event of a misfire on an M109/M109A1/A2/A3 howitzer (cold tube, charges 2 through 8).

After a failure to fire, actuate the firing mechanism two additional times in an attempt to fire. If the weapon still fails to fire, wait 2 minutes from the last attempt to fire and then remove and inspect the primer.

a. If the primer is not dented, the fault is in the firing mechanism. Repair the firing mechanism, prime and then fire the weapon.

b. If the primer is dented, the primer is at fault. Replace the primer with another primer and then fire the piece.

c. If the primer fired, the fault is with the propelling charge. Wait 10 minutes (8 minutes after removal and inspection of the primer), open the breech, and remove and dispose of the defective propelling charge. Reload the weapon with a new propelling charge and primer for firing.

State whether the following data are safe or unsafe to fire; if unsafe state why.

- 31. Unsafe, deflection exceeds left limit by 10 mils.
- 32. Unsafe, time is 0.4 second less than minimum time.
- 33. Unsafe, time is 2.0 seconds less than minimum time.

- ★34. List the action taken in the event of a misfire on an M109/M109A1/A2/A3 (hot tube, charge 3).

After a failure to fire, actuate the firing mechanism two additional times in an attempt to fire. If the weapon still fails to fire, wait 2 minutes from the last attempt to fire and then remove and inspect the primer.

a. If the primer is not dented, the fault is in the firing mechanism. Repair the firing mechanism, prime the weapon and then fire it within 5 minutes from the time the round was chambered.

b. If the primer is dented, the primer is at fault. Replace the primer with another primer and then fire the weapon within 5 minutes from the time the round is chambered.

c. If the primer fired, the fault is with the propelling charge. If it is a combat emergency, insert another primer and then attempt to fire the weapon within 5 minutes from the time the round was chambered.

d. If for any reason the projectile is not removed from the tube within 5 minutes of chambering, evacuate all personnel from the weapon and notify EOD for removal of the projectile.

35. Describe the method for measuring the greatest angle of site to a crest in front of the howitzer and list the five methods of determining piece-to-crest range.

Looking through the tube, sight along the lowest element of the bore and direct the movement of the tube until the line of site just clears the highest point on the crest in front of the howitzer. Center the cross-level and pitch-level bubbles and read the elevation, which is the greatest angle of site. The five methods of determining piece-to-crest range are MIL RELATION, TAPING, MAP MEASUREMENT, PACING, and ESTIMATION.

TEST II

Part 1. True and False

- 1. _____ The safety officer must compare the safety card minimum QE with the XO's minimum QE and use the larger as the minimum QE.
- 2. _____ In indirect fire, the safety officer must insure that the visible portion of the impact area is clear of personnel.
- 3. _____ The OIC may authorize the firing of all types of ammunition from a firing point, if he insures that the proper charge is being fired.
- 4. _____ Before illuminating rounds are fired, the safety officer must insure that the firing of those rounds is authorized on his safety card.
- 5. _____ The safety officer must insure that range clearance has been obtained before the battery may fire.
- 6. _____ CHECK FIRING will be commanded *only* by the safety officer.
- 7. _____ Firing will be halted when the range control commands CHECK FIRING.
- 8. _____ The safety officer will verify the boresight of each piece prior to firing in each position.

9. _____ Excess powder should be piled as high as possible for burning to prevent spreading of the flames and to reduce the chance of starting a range fire.
10. _____ Because of the great range of the M107 SP gun, drift must be considered in the computation of safety limits prior to the registration.

Part 2. Multiple Choice

11. Verifying the boresight of each weapon is the specific responsibility of the—
- section chief and safety officer.
 - safety officer and OIC of firing.
 - executive officer and range officer.
 - OIC of firing and FDO.
12. The safety officer has computed a minimum QE of 186 mils and the XO has determined a minimum QE of 195 mils for shell HE and fuzes quick and time. Which QE should be used as the safe minimum QE?
- 186.
 - 195.
 - Either 186 or 195.
 - 190.
13. When the safety diagram is being constructed for high-angle fire prior to a registration, how are the deflection limits altered?
- Left* limit is moved left by minimum drift.
Right limit is moved left by maximum drift.
 - Left* limit is moved left by maximum drift.
Right limit is moved left by minimum drift.
 - Left* limit is moved right by minimum drift.
Right limit is moved right by maximum drift.
 - The deflection limits are not altered.
14. In order to inscribe a GFT setting on a GFT after a registration has been completed, the manufacturer's hairline is placed over the—
- adjusted time.
 - adjusted elevation.
 - chart range.
 - adjusted quadrant.
15. When burning powder, unused flash reducers and igniters should be placed—
- on the DOWNWIND end of the row of charge increments.
 - in the igniter train of powder.
 - on the UPWIND end of the row of charge increments.
 - in a row over the top of the charge increments.

Part 3. Completion

16. Prior to departing for the field, all officers in the chain of command responsible for safety should read and understand five references. They are—
- _____
-

b. _____

c. _____

d. _____

e. _____

17. Equipment and material required by the safety officer in the field include—

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

18. Upon arrival at the prescribed firing point, the safety officer must check and verify the following:

a. _____

b. _____

c. _____

d. _____

19. To properly orient his aiming circle when the battery is laid by the grid azimuth method, the safety officer must insure that his aiming circle is no closer than _____ meters to artillery weapons.

20. The battery has been laid on an azimuth of 430 mils. You are prepared to check the lay. The declination constant of your aiming circle is 130 mils. What instrument reading would you place on the scales by use of the upper motion when you are preparing to orient your aiming circle on the azimuth of fire?

21. If a VT fuze does not seat properly in the fuze well, what actions should be taken?

22. Describe the procedures for burning unused powder increments.

23. At a firing point, how do you verify the declination constant on the aiming circle?

24. How does the safety officer verify the initial lay of the battery at a firing point?

25. Describe the procedures used by the safety officer in the testing target method to verify that the panoramic telescope and the direct fire telescope of each howitzer are alined with the bore of the howitzer.

Part 4. Performance

26. **Situation:** You are the executive officer of a 155-mm M109A1 battery firing shell HE, charge 5 green bag, fuzes M557, M564, and M514. The piece-to-crest range is 700 meters. The reported angles of site are as follows:

Number 1: +14 mils

Number 4: +14 mils

Number 2: +15 mils

Number 5: +13 mils

Number 3: +18 mils

Number 6: +12 mils

Required:

a. What is the XO's minimum QE for firing fuzes quick and mechanical time? _____

b. What is the minimum safe time for fuze VT M514? _____

c. What is the XO's minimum QE for firing fuze VT with a fuze setting less than the minimum safe time? _____

Show work:

a. Min QE (Q and T) _____ c. Min QE (VT) _____

b. Min safe time (VT) _____

27. Situation: You are the safety officer for a 155-mm M109A1 battery firing charge 4 green bag. The battery is laid on azimuth 2150.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	377	368
Intermediate range	341	327
Minimum range	324	320

b. Battery altitude: 339 meters.

c. The following data were taken from the safety card:

Safety limits for 155-mm SP howitzer, shell HE, fuzes M557, M564, and M514

Left limit: Az 1725

Minimum range: 3,700 meters

Right limit: Az 2535

Maximum range: 7,100 meters

Charge 4 green bag only

Low-angle fire only

Special instructions: From azimuth 1725 to azimuth 1925 the minimum range is 4,200 meters.

Required: Complete the safety diagram and compute the safety data.

Show work:

28. Situation continued: The battery has completed a precision registration and FDC announces the following registration data:

GFT A: Chg 4, lot XY, rg 4750, el 260, ti 15.2, df corr R12.

Required: Using these registration corrections, compute the modified safety diagram you will now use. (Use the given data from requirement 27.)

Show work:

29. Situation: You are the safety officer for a 155-mm M109A1 battery firing charges 3 and 4 green bag. The battery is laid on azimuth 5900.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	395	389
Minimum range	388	364

b. Battery altitude: 341 meters.

c. The following data were taken from the range safety card:

Left limit: Azimuth 5580

Minimum range: 5,200 meters

Right limit: Azimuth 6260

Maximum range: 6,900 meters

Charges 3 and 4 white bag only

High-angle fire only

Required: Complete the safety diagram and compute the safety data.

Show work:

30. Situation: You are the safety officer for a 155-mm M109A1 battery firing charge 4 green bag. The battery is laid on azimuth 2050.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	377	368
Minimum range	324	320

b. Battery altitude: 339 meters.

c. The following data were taken from the safety card:

Safety limits for 155-mm SP howitzer, shell ICM M449E1

Left limit: Azimuth 1675

Minimum range: 4400 meters

Right limit: Azimuth 2435

Maximum range: 7000 meters

Charge 4 green bag only

Low-angle fire only

Required: Complete the safety diagram and compute the safety data.

Show work:

31. **Situation:** You are the safety officer for a 155-mm M109A1 battery firing charge 5 green bag. The battery is laid on azimuth 2050.

a. You have determined the following data:

	Maximum altitude	Minimum altitude
Maximum range	377	368
Minimum range	385	320

b. Battery altitude: 339 meters.

c. The following data were taken from the range safety card:

Left limit: Azimuth 1675

Maximum range: 7000 meters

Right limit: Azimuth 2436

Minimum range: 4400 meters

Charge 5 green bag only

Shell illuminating only

Required: Complete the safety diagram and compute the safety data.

Show work:

SOLUTION II

Part 1. True and False

- | | |
|----------|----------|
| 1. True | 6. False |
| 2. True | 7. True |
| 3. False | 8. True |
| 4. True | 9. False |
| 5. True | 10. True |

Part 2. Multiple Choice

- | | |
|-------|-------|
| 11. a | 14. c |
| 12. b | 15. c |
| 13. a | |

Part 3. Completion

16. Prior to departing for the field, all officers in the chain of command should read and understand five references.

- a. AR 385-63.
- b. FM 6-50, chapter 15.
- c. TM 43-0001-28.
- d. Appropriate FM and TM for the weapon.
- e. Post range regulations.

17. Equipment and material required by the safety officer in the field include:

- a. Authorized safety card.
- b. Applicable tabular firing tables.
- c. Applicable graphical firing tables.
- d. Applicable graphical site tables.
- e. Map of the area.
- f. Aiming circle.

18. Upon arrival at the prescribed firing point, the safety officer must check and verify the following:

- a. Verify that the safety card applies to the firing unit, exercise, and date.
- b. Verify that the battery is in the position as specified on the card.
- c. Verify the boresighting of each weapon.
- d. Verify the laying of the battery.

19. To properly orient his aiming circle when the battery is laid by the grid azimuth method, the safety officer must insure that his aiming circle is no closer than 75 meters to artillery weapons.

20. The battery has been laid on an azimuth of 430 mils. You are preparing to check the lay. The declination constant of your aiming circle is 130 mils. What instrument reading would you place on the scales by use of the upper motion when you are preparing to orient your aiming circle on the azimuth of fire?

6,100 mils

21. If a VT fuze does not seat properly in the fuze well, what actions should be taken?

Remove the fuze and check to see if the supplementary charge is still in the fuze well. If it is, remove it and install the fuze. Then if the fuze does not seat properly, remove it and turn it in to the ammunition section.

22. Describe the procedures for burning unused powder increments.

The burning site will be at least 200 feet from personnel and equipment. All powder charge increments to be destroyed should be placed in a single-layer row not more than 12 inches wide. The row of increments should be placed so that burning will progress into the direction of the wind. A train of combustible material approximately 15 feet long should be placed perpendicular to, and at the downwind end of, the row of increments. The combustible materials should be lighted at the end farthest from the row of increments. Igniter powder (red devils) and flash reducers will be placed at the upwind end of the row of increments to be destroyed.

23. At a firing point, how do you verify the declination constant on the aiming circle?

Set up the aiming circle over any point from which the azimuth to another visible point is known. Using the upper motion, set the known azimuth on the scales. Using the lower motion, sight on

the known point. Release the magnetic needle, and using the upper motion, center it. Read the value on the scales and compare it to the declination constant. If the two values compare within ± 2 mils, the declination constant is valid. If not, the aiming circle should be redeclinated in accordance with FM 6-2.

24. How does the safety officer verify the initial lay of the battery at a firing point?

A declinated aiming circle, oriented on the azimuth of lay, will be set up at least 10 meters away from the executive officer's aiming circle. Referred readings will be taken between the two aiming circles and they must agree with the criteria dictated by local range regulations/unit SOP. The safety officer will command the pieces to refer to his aiming circle after the weapon aiming points have been established. The referred readings between the safety officer's aiming circle and the pieces must agree with criteria established by local range regulations/unit SOP.

25. Describe the procedures used by the safety officer using the testing target method to verify that the panoramic telescope and the direct fire telescope of each howitzer are alined parallel with the bore of the howitzer.

a. The safety officer will verify that the panoramic telescope gunner's aid counter is set to 0, the muzzle crosshairs are centered on the center aiming diagram, the telescope mount is level, and the azimuth counter reads 3,200 mils when the panoramic telescope reticle is laid precisely on the left aiming diagram.

b. The safety officer will verify that the elbow telescope cross-level bubble is centered, the range gageline of the elbow telescope is set on zero elevation, and the reticle of the elbow telescope coincides with the right pattern of the testing target.

Part 4. Performance

Requirement 26 (Weight 15)

✕ a	+18 (value -1)	Expression errors	-1
✕ b	+ 8 (value -1)	Mathematical error	-1
✕ c	+ 1 (value -1)		
✕ 1	+27 = +27		
✕ 2	27 (value -2)		
✕ 3	2 (value -1)		

a. MIN QE 56

(Maximum cut -6)

b. MST = 2.2

+5.5

= 7.7 or 8.0

RG 800

(-1)

(-1)

(-1)

(Maximum cut for this part of problem -3)

✕ a	+18		
✕ b	+128		
✕ c	+ 1	(Cuts same as above)	
✕ 1	+147 = +147	(Maximum -6)	
✕ 2	31		
✕ 3	2		

c. Min QE 180

Entire problem maximum cut -15

Maximum cuts for expression
for entire problem -2

Requirement 27 (Weight 25)

Diagram construction:

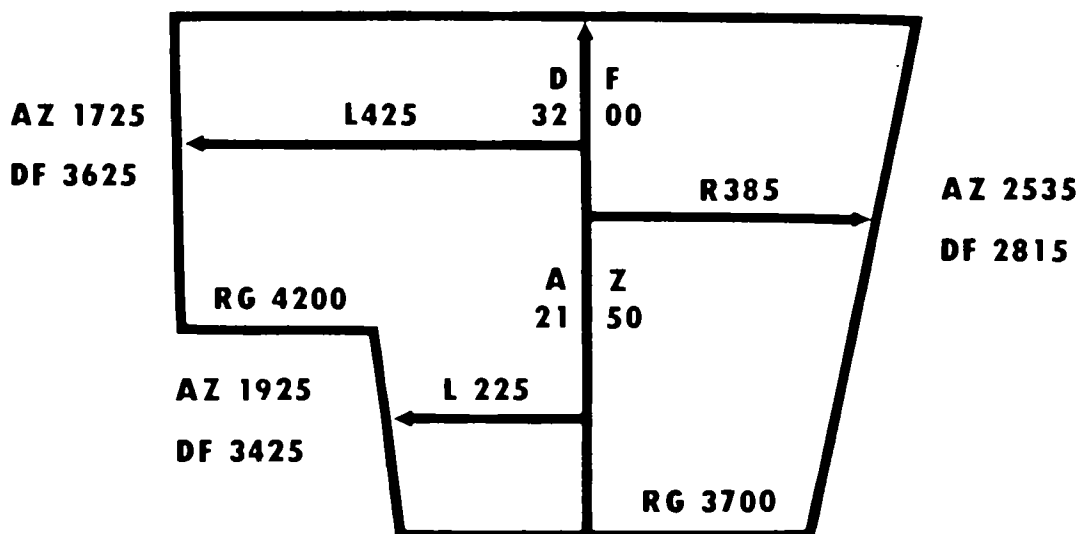
Deflection and azimuth—1 ea

Dog leg positioning—3

Expression errors—1

Math errors—1

Maximum cut -6

DF OTHER THAN 3200 -3
RG 7100

CHG	RG	ALT USED	VI	SI	EL	QE	FS M564	TI FL	FS M514
4	7100	368	+29	+6	489	495			
4	4200	341	+2	+1	238	239	14.5	14.7 + 5.5	=20.2 = 21.0
4	3700	324	-15	-4	205	201	12.6	12.7 + 5.5	=18.2 = 19.0
			CUT:	-2 EA	-1 EA		-2 EA		-3 EA

MAXIMUM CUT FOR COMPLETE PROBLEM - 25

Requirement 28 (Weight 25)

Diagram: Df and Az — 2 each (maximum cut -6)

Failure to use GFT setting -15

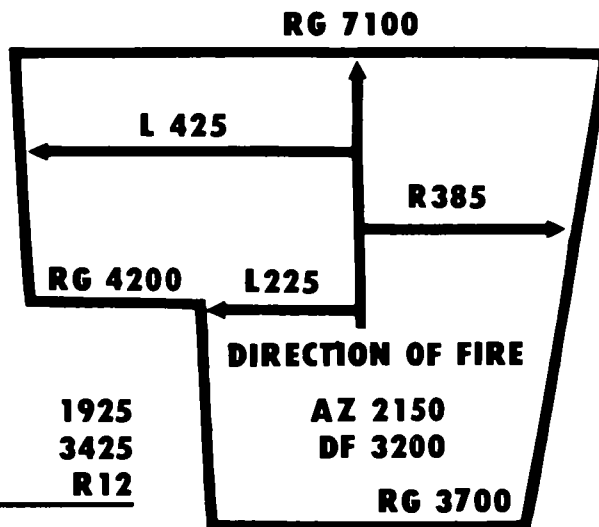
FS M514, did not apply 5.5 —2

Expression —1

Math error —1

DF OTHER THAN 3200 -3

AZ 1725
DF 3625
DF CORR R12
DF 3613



AZ 2535
DF 2815
DF CORR R12
DF 2803

AZ 1925
DF 3425
DF CORR R12
DF 3413

RG	SI	EL	QE	FS M564	TI FL	FS M514
7100	+ 6	450	456			
4200	+ 1	225	226	13.2	13.9 + 5.5 =	19.4 = 20.0
3700	- 4	194	190	11.5	12.0 + 5.5 =	17.5 = 18.0
CUT:	-1 EA	-2 EA		-1 EA		-3 EA

MAXIMUM CUT FOR COMPLETE PROBLEM- 25

Requirement 29 (Weight 20)

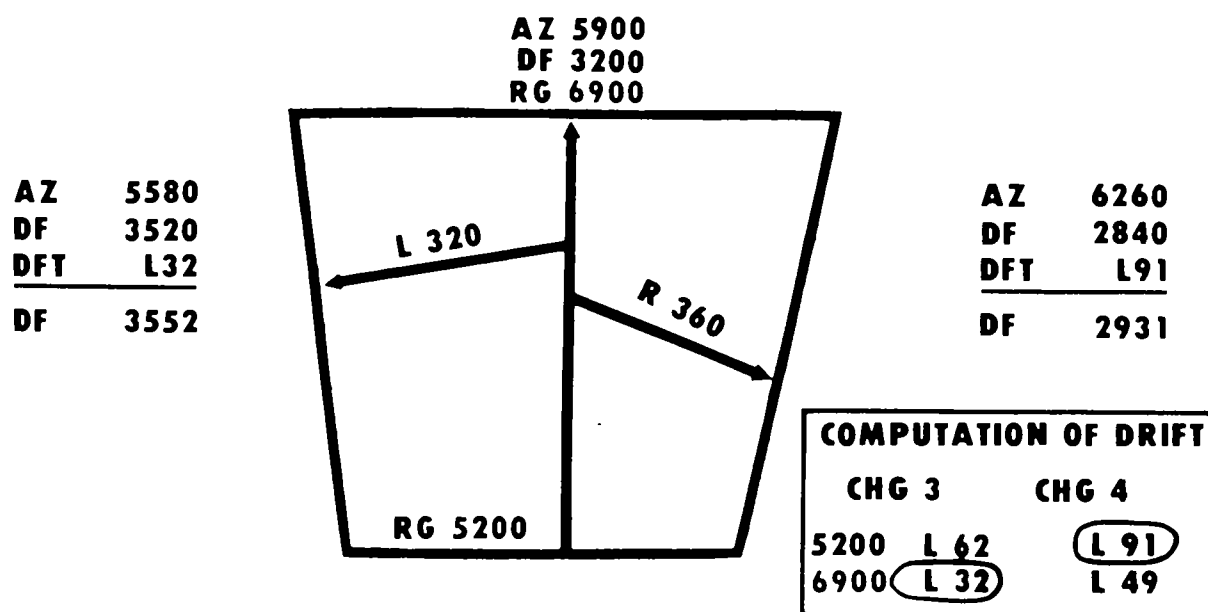
Diagram: Df and Az — 2 each (maximum cut -4)

Drift —2 ea (maximum cut -4)

Math errors —1

Expression errors —1

DF OTHER THAN 3200 -3



CHG	RG	EL	ANGLE OF SITE	10m SI FAC	SI	QE
4	6900	1089	+ 7	- 3.7	-3	1086
4	5200	1235	+ 9	- 1.0	-1	1234
3	6900	SAFE				
3	5200	1123	+ 9	- 2.8	-3	1120
	CUT:	-2 EA			-2 EA	

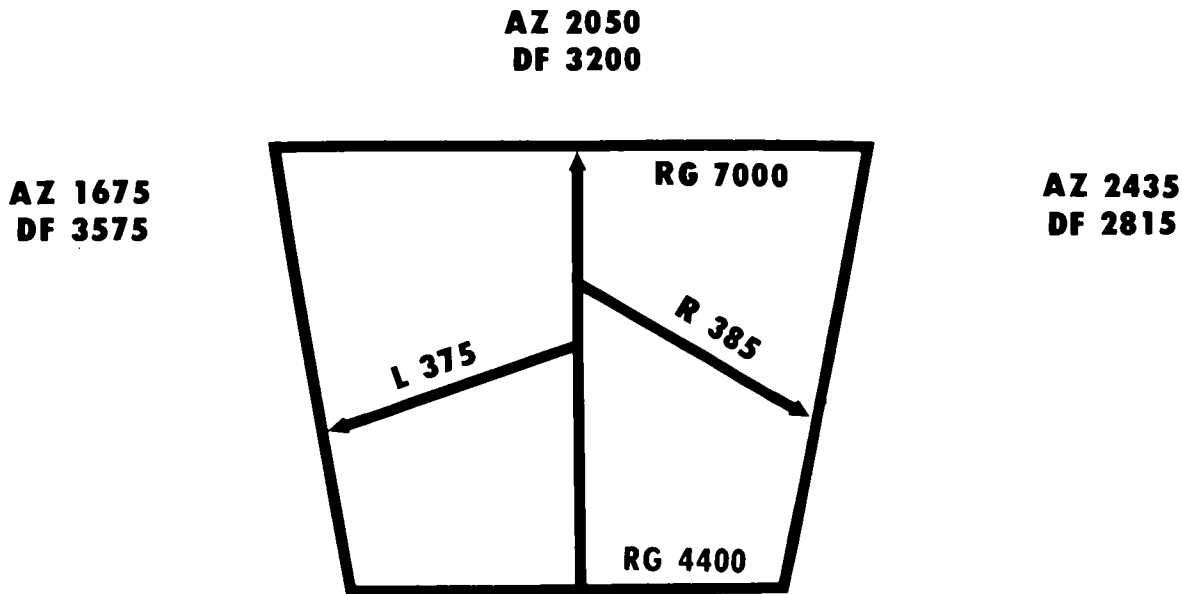
MAXIMUM CUT FOR COMPLETE PROBLEM -20

Requirement 30 (Weight 10)

Diagram: Df and Az — 1 each (maximum cut -2)

Expression errors —1

Math errors —1



DIRECTION OF FIRE

CHG	RG	RG TO IMPACT	HE QE	CORR ICM	SI	QE	FS M564
4	7000	6982	450	+ 28	+ 6	484	
4	4400	4414	165	+ 91	- 4	252	15.4
		CUT:	-1 EA	-1 EA		-1 EA	- 2

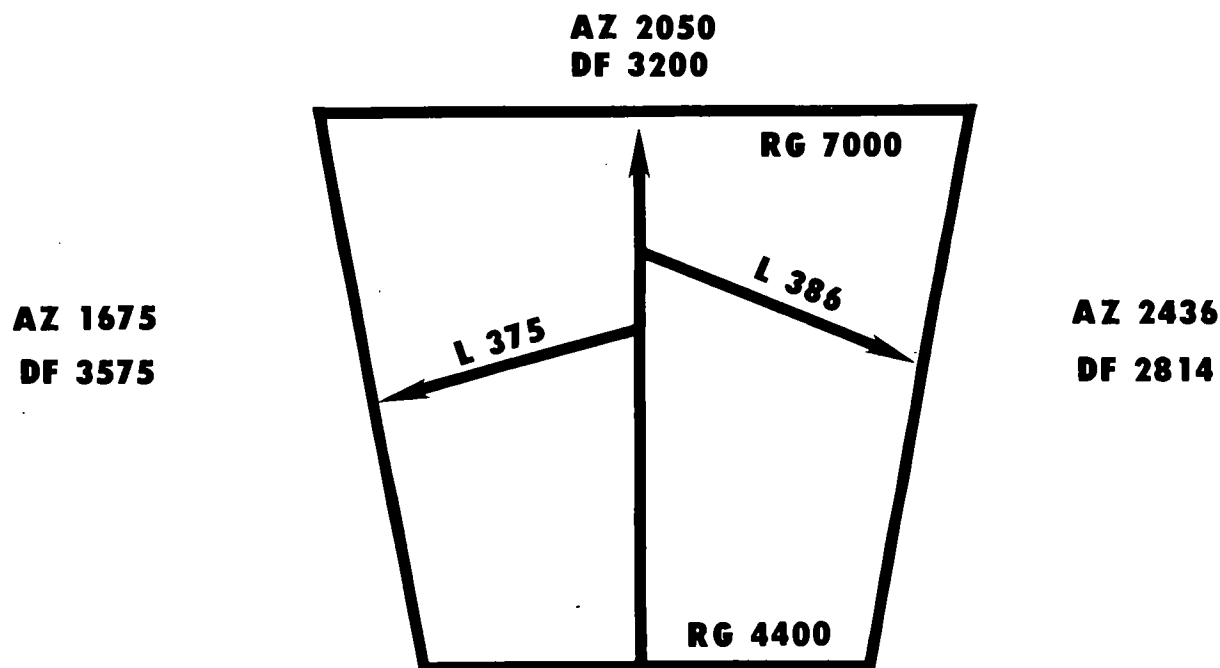
MAXIMUM CUT FOR COMPLETE PROBLEM -10

Requirement 31 (Weight 10)

Diagram: Df and Az —1 ea (maximum cut -2)

Expression errors —1

Math errors —1



CHG	RG	MIN ALT	BTRY ALT	VI	SI		EL	QE
5GB	7000	368	339	+29	+5		373	378
				CUT:	-1		-1	-1
CHG	RG	MAX ALT	BTRY ALT	VI	SI	EL	QE	FS M564
5GB	4400	385	339	+46	+11	204	215	13.8
				CUT:	-1	-1	-1	-2

MAXIMUM CUT FOR COMPLETE PROBLEM -10



APPENDIX F

MINIMUM QE RAPID FIRE TABLES

★F-1. General

These rapid fire tables include all the elements of the XO's min QE discussed in chapter 10 *except* angle "a" (site to crest). Separate tables are included for each weapon/fuze/propellant combination. The value listed for elevation (EL) in all tables is the sum of the tabular firing table (TFT) elevation, 2 forks, the vertical angle corresponding to the appropriate vertical clearance, and the complementary angle of site for +300 mils angle of site. If the sum of the vertical angle and the complementary angle of site is greater than +300 mils, you will have to compute the data as shown in chapter 10.

The time (Ti) listed in the armed VT fuze tables (M513, M514, M728) includes the TFT time of flight plus 5.5 seconds expressed to the next higher whole second (minimum safe time) for each listed range. When the time set on the VT fuze is equal to or greater than the time listed in the table, the XO's min QE for fuzes other than VT is used (unarmed VT).

★F-2. Use of the Tables

a. Enter the table at the piece-to-crest range and determine the minimum elevation for the appropriate charge(s).

b. Select the greatest angle of site to crest reported by the chiefs of section.

c. Add these two values. The sum is the minimum quadrant elevation.

EXAMPLF 155-mm howitzer M109A1 range to the crest is 900 meters. Angles of site reported by the chiefs of section are +80, +78, +74, +68, +72, +79. Determine the minimum quadrant elevation for charge 5 white bag, fuze M564.

SOLUTION: Enter table V at range 900 meters.

Value from the table for charge 5	40
--------------------------------------	----

Greatest angle of site to crest +80 mils

XO's min QE	+120 mils
-------------	-----------

There are restrictions on the use of the VT fuze when firing certain charges on some weapon systems. These areas are indicated on the tables by shading. For the specific restrictions, refer to the weapon-operator's manual and/or TM 43-0001-28 (which has superseded TM 9-1300-203).

The range-to-crest column in the rapid fire tables is the same as piece-to-crest range.

The Ti column in the rapid fire tables is the same as minimum safe time (MST).

Tables listed for the M109A1 are applicable to the M109A2/A3 and M198. Tables listed for the M110A1 are applicable to the M110A2.

RAPID FIRE TABLE I

FUZE M557, M564

PROPELLANT M67

WEAPON M101A1

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	69	66	64	62	60	57	56	3700	603	396	269	193	134
200	57	52	48	44	41	36	33	3800	626	409	279	199	139
300	61	54	48	42	37	31	27	3900	647	421	287	207	143
400	73	61	54	46	39	31	25	4000	671	435	295	212	148
500	84	73	61	51	42	33	26	4500		541	350	245	173
600	100	87	73	58	46	36	27	5000		709	413	284	201
700	115	97	81	64	51	39	29	5500			490	324	229
800	128	108	90	73	55	43	30	6000			593	370	259
900	141	121	99	80	60	46	32	6500			757	423	292
1000	157	133	108	87	66	50	35	7000				488	329
1100	180	150	123	96	73	54	37	7500				569	369
1200	196	165	133	104	81	58	39	8000				684	414
1300	211	176	143	111	86	62	41	8500					465
1400	226	189	153	119	92	66	44	9000					529
1500	243	204	165	129	98	71	47	9500					609
1600	276	227	183	141	106	77	50	10000					734
1700	294	241	193	149	111	81	52						
1800	312	255	203	157	117	85	56						
1900	329	269	216	165	123	90	59						
2000	349	285	228	176	129	95	62						
2100	403	317	249	190	140	103	67						
2200	422	334	262	199	146	108	70						
2300	443	351	274	208	153	113	74						
2400	465	367	288	219	159	118	77						
2500	489	385	300	228	166	123	81						
2600	619	439	328	244	175	128	85						
2700	644	456	342	254	182	134	89						
2800	673	476	355	265	191	139	92						
2900	706	496	371	275	198	144	98						
3000	742	517	384	285	205	149	102						
3100	783	646	430	309	217	157	107						
3200		670	447	319	224	162	112						
3300		696	462	329	233	168	116						
3400		725	479	342	240	173	120						
3500		757	497	352	247	179	124						
3600		795	584	384	262	187	130						

RAPID FIRE TABLE I

Range to Crest	FUZE M513		PROPELLANT M67		WEAPON M101A1					
	CHG		CHG		CHG		CHG		CHG	
	1	2	3	4	5	6	7			
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0
200	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0
300	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0
400	264	8.0	225	8.0	213	8.0	184	8.0	173	8.0
500	236	9.0	225	8.0	213	8.0	184	8.0	173	8.0
600	227	9.0	214	9.0	200	9.0	184	8.0	173	8.0
700	224	10.0	206	9.0	190	9.0	173	9.0	160	8.0
800	223	10.0	203	10.0	185	9.0	168	9.0	150	9.0
900	226	11.0	206	10.0	184	10.0	165	9.0	145	9.0
1000	233	11.0	209	11.0	184	10.0	163	10.0	142	9.0
1100	250	12.0	220	11.0	193	11.0	166	10.0	143	10.0
1200	259	12.0	228	12.0	196	11.0	167	11.0	144	10.0
1300	270	13.0	235	12.0	202	12.0	170	11.0	145	10.0
1400	281	14.0	244	13.0	208	12.0	174	11.0	147	11.0
1500	294	14.0	255	13.0	216	13.0	180	12.0	149	11.0
1600	323	15.0	274	14.0	230	13.0	188	12.0	153	11.0
1700	339	15.0	286	14.0	238	14.0	194	13.0	156	12.0
1800	355	16.0	298	15.0	246	14.0	200	13.0	160	12.0
1900	369	17.0	309	16.0	256	15.0	205	14.0	163	13.0
2000	387	17.0	323	16.0	266	15.0	214	14.0	167	13.0
2100	439	18.0	353	17.0	285	16.0	226	14.0	176	13.0
2200	457	19.0	369	17.0	297	16.0	234	15.0	181	14.0
2300	476	19.0	384	18.0	307	17.0	241	15.0	186	14.0
2400	496	20.0	398	19.0	319	17.0	250	16.0	190	14.0
2500	519	21.0	415	19.0	330	18.0	258	16.0	196	15.0
2600	649	21.0	469	20.0	358	18.0	274	17.0	205	15.0
2700	673	22.0	485	20.0	371	19.0	283	17.0	213	16.0
2800	701	23.0	504	21.0	383	19.0	293	18.0	219	16.0
2900	733	24.0	523	22.0	398	20.0	302	18.0	225	16.0
3000	768	25.0	543	23.0	410	21.0	311	19.0	231	17.0
3100			671	23.0	455	21.0	334	19.0	242	17.0
3200			694	24.0	471	22.0	343	20.0	248	18.0
3300			719	25.0	485	22.0	352	20.0	256	18.0
3400			747	26.0	501	23.0	364	21.0	262	18.0

RAPID FIRE TABLE 1

FUZE M513

PROPELLANT M67

WEAPON M101A1

[illegible]

RAPID FIRE TABLE I

Range to Crest	FUZE M728		PROPELLANT M67				WEAPON M101A1			
	CHG		CHG		CHG		CHG		CHG	
	1	2	3	4	5	6	7	8	9	10
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	188	8.0	164	8.0	152	8.0	133	8.0	122	8.0
200	188	8.0	164	8.0	152	8.0	133	8.0	122	8.0
300	188	8.0	164	8.0	152	8.0	133	8.0	122	8.0
400	188	8.0	164	8.0	152	8.0	133	8.0	122	8.0
500	175	9.0	164	8.0	152	8.0	133	8.0	122	8.0
600	171	9.0	163	9.0	149	9.0	133	8.0	122	8.0
700	180	10.0	162	9.0	146	9.0	129	9.0	116	8.0
800	185	10.0	165	10.0	147	9.0	130	9.0	112	9.0
900	193	11.0	173	10.0	151	10.0	132	9.0	112	9.0
1000	203	11.0	179	11.0	154	10.0	133	10.0	112	9.0
1100	222	12.0	192	11.0	165	11.0	138	10.0	115	10.0
1200	234	12.0	203	12.0	171	11.0	142	11.0	119	10.0
1300	246	13.0	211	12.0	178	12.0	146	11.0	121	10.0
1400	259	14.0	222	13.0	186	12.0	155	11.0	125	11.0
1500	274	14.0	235	13.0	196	13.0	160	12.0	129	11.0
1600	304	15.0	255	14.0	211	13.0	169	12.0	134	11.0
1700	321	15.0	268	14.0	220	14.0	176	13.0	138	12.0
1800	338	16.0	281	15.0	229	14.0	183	13.0	143	12.0
1900	353	17.0	293	16.0	240	15.0	189	14.0	147	13.0
2000	372	17.0	308	16.0	251	15.0	199	14.0	152	13.0
2100	424	18.0	338	17.0	270	16.0	211	14.0	161	13.0
2200	443	19.0	355	17.0	283	16.0	220	15.0	167	14.0
2300	463	19.0	371	18.0	294	17.0	218	15.0	173	14.0
2400	483	20.0	385	19.0	306	17.0	237	16.0	177	14.0
2500	507	21.0	403	19.0	318	18.0	246	16.0	184	15.0
2600	637	21.0	457	20.0	346	18.0	262	17.0	193	15.0
2700	662	22.0	474	20.0	360	19.0	272	17.0	202	16.0
2800	690	23.0	493	21.0	372	19.0	282	18.0	208	16.0
2900	722	24.0	512	22.0	387	20.0	291	18.0	214	16.0
3000	758	25.0	533	23.0	400	21.0	301	19.0	221	17.0
3100			662	23.0	446	21.0	325	19.0	223	17.0
3200			685	24.0	462	22.0	334	20.0	239	18.0
3300			710	25.0	476	22.0	343	20.0	247	18.0
3400			738	26.0	492	23.0	355	21.0	253	18.0

RAPID FIRE TABLE I

[illegible]

RAPID FIRE TABLE II

FUZE M557, M564

PROPELLANT M67

WEAPON M102

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	67	65	63	61	59	58	57	3700	472	331	227	176	117
200	54	50	46	42	39	36	34	3800	488	340	234	181	123
300	58	51	45	40	35	30	27	3900	502	352	240	187	128
400	68	57	50	43	36	30	25	4000	519	362	247	192	132
500	78	68	56	47	39	31	25	4500	690	436	290	227	157
600	91	79	65	53	42	33	25	5000		531	337	257	180
700	105	89	74	59	46	36	27	5500		670	387	298	208
800	116	98	82	64	50	38	28	6000			450	334	234
900	128	110	89	70	54	41	29	6500			527	389	270
1000	143	121	98	77	59	45	31	7000			633	430	299
1100	162	136	109	86	64	49	33	7500				516	340
1200	177	147	118	93	69	53	36	8000				565	375
1300	190	159	128	99	74	56	37	8500					431
1400	205	170	137	106	79	60	40	9000					471
1500	219	182	146	113	84	64	43	9500					561
1600	248	203	159	124	91	69	45	10000					609
1700	262	214	170	130	95	72	47						
1800	278	226	179	137	101	76	50						
1900	293	240	189	147	106	81	53						
2000	310	252	199	154	112	85	56						
2100	349	280	218	166	119	92	60						
2200	367	293	228	173	125	97	63						
2300	385	308	238	181	131	101	66						
2400	404	321	249	189	136	106	69						
2500	424	337	261	199	144	111	72						
2600	493	372	282	212	152	115	75						
2700	514	389	292	220	158	119	78						
2800	536	403	305	228	164	124	81						
2900	558	421	316	236	170	129	85						
3000	584	438	328	245	176	134	88						
3100		503	359	263	185	142	94						
3200		522	371	270	191	148	98						
3300		541	385	281	198	155	102						
3400		562	398	289	204	160	105						
3500		583	413	300	210	165	109						
3600			457	322	221	171	113						

RAPID FIRE TABLE II

FUZE M513

PROPELLANT M67

WEAPON M102

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
200	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
300	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
400	259	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
500	230	8.0	220	8.0	208	8.0	180	8.0	155	8.0	133	8.0	108	8.0
600	218	9.0	206	9.0	194	8.0	180	8.0	155	8.0	133	8.0	108	8.0
700	214	9.0	198	9.0	183	9.0	168	9.0	155	8.0	133	8.0	108	8.0
800	211	10.0	193	10.0	177	9.0	159	9.0	145	8.0	133	8.0	108	8.0
900	213	10.0	195	10.0	174	10.0	155	9.0	139	9.0	126	8.0	108	8.0
1000	219	11.0	197	11.0	174	10.0	153	10.0	135	9.0	121	9.0	108	8.0
1100	232	11.0	206	11.0	179	11.0	156	10.0	134	9.0	119	9.0	103	8.0
1200	240	12.0	210	12.0	181	11.0	156	10.0	132	10.0	116	9.0	99	9.0
1300	249	13.0	218	12.0	187	11.0	158	11.0	133	10.0	115	10.0	96	9.0
1400	260	13.0	225	12.0	192	12.0	161	11.0	133	10.0	115	10.0	95	9.0
1500	270	14.0	233	13.0	197	12.0	164	12.0	135	11.0	115	10.0	94	9.0
1600	295	14.0	250	13.0	206	13.0	171	12.0	138	11.0	115	10.0	92	10.0
1700	307	15.0	259	14.0	215	13.0	175	12.0	140	11.0	116	11.0	92	10.0
1800	321	15.0	269	15.0	222	14.0	180	13.0	144	12.0	119	11.0	93	10.0
1900	333	16.0	280	15.0	229	14.0	187	13.0	146	12.0	120	11.0	93	10.0
2000	348	16.0	290	16.0	237	15.0	192	14.0	150	12.0	123	12.0	94	11.0
2100	385	17.0	316	16.0	254	15.0	202	14.0	155	13.0	127	12.0	96	11.0
2200	402	18.0	328	17.0	263	15.0	208	14.0	160	13.0	131	12.0	98	11.0
2300	418	18.0	341	17.0	271	16.0	214	15.0	164	14.0	134	13.0	99	11.0
2400	435	19.0	352	18.0	280	16.0	220	15.0	167	14.0	136	13.0	100	12.0
2500	454	20.0	367	18.0	291	17.0	229	16.0	174	14.0	140	13.0	102	12.0
2600	523	20.0	402	19.0	312	17.0	242	16.0	182	15.0	144	14.0	105	12.0
2700	543	21.0	418	19.0	321	18.0	249	16.0	187	15.0	148	14.0	107	13.0
2800	564	22.0	431	20.0	333	18.0	256	17.0	192	15.0	152	14.0	109	13.0
2900	585	22.0	448	21.0	343	19.0	263	17.0	197	16.0	156	15.0	112	13.0
3000	610	23.0	464	21.0	354	19.0	271	18.0	202	16.0	160	15.0	114	13.0
3100			528	22.0	384	20.0	288	18.0	210	16.0	167	15.0	119	14.0
3200			546	23.0	395	20.0	296	19.0	215	17.0	171	16.0	122	14.0
3300			564	23.0	408	21.0	304	19.0	221	17.0	177	16.0	125	14.0
3400			584	24.0	420	22.0	312	20.0	226	18.0	182	16.0	127	15.0
3500			605	25.0	435	22.0	322	20.0	232	18.0	187	17.0	131	15.0
3600			793	25.0	478	23.0	343	20.0	242	18.0	191	17.0	134	15.0
3700					493	23.0	352	21.0	248	19.0	197	17.0	138	16.0

RAPID FIRE TABLE II

FUZE M513

Range to Crest	CHG 3	
	EL	TI
3800	508	24.0
3900	521	25.0
4000	538	25.0
4500	707	29.0
5000		
5500		
6000		
6500		
7000		
7500		
8000		
8500		
9000		
9500		
10000		

PROPELLANT M67

CHG 4		CHG 5	
EL	TI	EL	TI
360	21.0	254	19.0
371	22.0	259	20.0
381	22.0	266	20.0
453	25.0	307	22.0
546	28.0	352	24.0
684	31.0	401	26.0
		463	29.0
		539	31.0
		644	34.0

WEAPON M102

CHG 6		CHG 7	
EL	TI	EL	TI
201	18.0	143	16.0
206	18.0	147	16.0
211	19.0	151	17.0
243	20.0	174	18.0
271	22.0	195	20.0
312	24.0	222	22.0
346	26.0	247	24.0
401	28.0	282	25.0
440	31.0	310	27.0
526	33.0	350	29.0
575	36.0	385	32.0
		440	34.0
		480	36.0
		569	39.0
		617	42.0

RAPID FIRE TABLE II

Range to Crest	FUZE M728		PROPELLANT M67				WEAPON M102			
	CHG		CHG		CHG		CHG		CHG	
	1	2	3	4	5	6	7	8	9	10
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	183	8.0	159	8.0	147	8.0	129	8.0	111	8.0
200	183	8.0	159	8.0	147	8.0	129	8.0	111	8.0
300	183	8.0	159	8.0	147	8.0	129	8.0	111	8.0
400	183	8.0	159	8.0	147	8.0	129	8.0	111	8.0
500	169	8.0	159	8.0	147	8.0	129	8.0	111	8.0
600	167	9.0	155	9.0	143	8.0	129	8.0	111	8.0
700	170	9.0	154	9.0	139	9.0	124	9.0	111	8.0
800	173	10.0	155	10.0	139	9.0	121	9.0	107	8.0
900	180	10.0	162	10.0	141	10.0	122	9.0	106	9.0
1000	189	11.0	167	11.0	144	10.0	123	10.0	105	9.0
1100	204	11.0	178	11.0	151	11.0	128	10.0	106	9.0
1200	215	12.0	185	12.0	156	11.0	131	10.0	107	10.0
1300	225	13.0	194	12.0	163	11.0	134	11.0	109	10.0
1400	238	13.0	203	12.0	170	12.0	139	11.0	111	10.0
1500	250	14.0	213	13.0	177	12.0	144	12.0	115	11.0
1600	276	14.0	231	13.0	187	13.0	152	12.0	119	11.0
1700	289	15.0	241	14.0	197	13.0	157	12.0	122	11.0
1800	304	15.0	252	15.0	205	14.0	163	13.0	127	12.0
1900	317	16.0	264	15.0	213	14.0	171	13.0	130	12.0
2000	335	16.0	275	16.0	222	15.0	177	14.0	135	12.0
2100	370	17.0	301	16.0	239	15.0	187	14.0	140	13.0
2200	388	18.0	314	17.0	249	15.0	194	14.0	146	13.0
2300	405	18.0	328	17.0	258	16.0	201	15.0	151	14.0
2400	422	19.0	339	18.0	267	16.0	207	15.0	154	14.0
2500	442	20.0	355	18.0	279	17.0	217	16.0	162	14.0
2600	511	20.0	390	19.0	300	17.0	230	16.0	170	15.0
2700	532	21.0	407	19.0	310	18.0	238	16.0	176	15.0
2800	553	22.0	420	20.0	322	18.0	245	17.0	181	15.0
2900	574	22.0	437	21.0	332	19.0	252	17.0	186	16.0
3000	600	23.0	454	21.0	344	19.0	261	18.0	192	16.0
3100			519	22.0	375	20.0	279	18.0	201	16.0
3200			537	23.0	386	20.0	287	19.0	205	17.0
3300			555	23.0	399	21.0	295	19.0	212	17.0
3400			575	24.0	411	22.0	303	20.0	217	18.0
3500			596	25.0	426	22.0	313	20.0	223	18.0
3600			784	25.0	469	23.0	334	20.0	233	18.0
3700					485	23.0	344	21.0	240	19.0

RAPID FIRE TABLE II

Range to Crest	FUZE M728		PROPELLANT M67				WEAPON M102			
	CHG		CHG		CHG		CHG		CHG	
	1	2	3	4	5	6	7			
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
3800			500	24.0	352	21.0	246	19.0	193	18.0
3900			513	25.0	363	22.0	251	20.0	196	18.0
4000			530	25.0	373	22.0	258	20.0	203	19.0
4500			700	29.0	446	25.0	300	22.0	236	20.0
5000					540	28.0	346	24.0	265	22.0
5500					678	31.0	395	26.0	306	24.0
6000							458	29.0	341	26.0
6500							534	31.0	396	28.0
7000							640	34.0	436	31.0
7500									522	33.0
8000									571	36.0
8500										
9000										
9500										
10000										

RAPID FIRE TABLE III

FUZE M557, M564

PROPELLANT GREEN BAG M3A1

WEAPON M114A1

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	Range to Crest	CHG 2	CHG 3	CHG 4	CHG 5
100	67	64	61	60	57	3400	456	314	220	162
200	54	48	43	40	36	3500	471	325	229	169
300	57	48	41	36	31	3600	539	349	242	177
400	65	53	45	37	31	3700	557	359	249	182
500	77	61	50	41	32	3800	575	372	256	187
600	90	70	56	44	35	3900	595	382	263	193
700	101	80	62	48	38	4000	617	393	270	200
800	112	89	68	53	41	4500	753	479	316	230
900	125	97	75	57	44	5000		594	371	265
1000	138	107	84	63	48	5500			430	300
1100	156	120	92	69	51	6000			505	342
1200	170	132	100	75	56	6500			606	387
1300	182	141	106	79	59	7000				439
1400	196	151	114	85	63	7500				501
1500	211	161	122	91	68	8000				576
1600	237	179	132	99	73	8500				682
1700	251	189	141	104	76					
1800	265	199	149	110	81					
1900	280	210	157	116	86					
2000	296	223	165	122	90					
2100	331	242	178	130	96					
2200	348	254	186	135	99					
2300	366	267	197	141	108					
2400	392	278	205	147	112					
2500	401	290	213	154	117					
2600	460	318	228	163	122					
2700	479	330	237	171	127					
2800	500	342	247	177	132					
2900	521	357	256	184	137					
3000	543	370	265	190	142					
3100	696	400	283	201	149					
3200	720	424	295	207	154					
3300	748	439	304	214	159					

RAPID FIRE TABLE III

FUZE M557, M564

PROPELLANT WHITE BAG M4A2

WEAPON M114A1

Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	61	59	57	56	55	3400	307	216	164	113	73
200	43	39	56	33	32	3500	317	225	169	116	75
300	41	36	30	27	24	3600	338	236	178	121	78
400	43	37	30	25	22	3700	349	243	183	125	82
500	48	40	32	25	22	3800	361	250	189	129	85
600	56	43	35	27	21	3900	371	259	194	133	87
700	62	47	38	29	22	4000	383	265	199	137	90
800	68	51	41	30	23	4500	461	310	230	162	105
900	74	58	43	32	23	5000	561	361	265	186	119
1000	83	63	48	34	25	5500	711	419	301	213	138
1100	91	68	51	36	27	6000		488	342	237	155
1200	98	74	55	39	29	6500		576	386	268	177
1300	104	78	60	40	30	7000		703	437	298	188
1400	114	83	65	43	31	7500			497	333	222
1500	121	89	69	46	33	8000			571	371	246
1600	131	96	74	49	35	8500			673	411	272
1700	138	103	78	51	36	9000				458	301
1800	147	109	82	54	38	9500				512	330
1900	155	114	87	57	40	10000				577	362
2000	162	120	91	60	42	10500				661	398
2100	176	128	97	64	44	11000					437
2200	184	133	102	68	46	11500					480
2300	192	139	106	71	48	12000					530
2400	202	147	111	76	50	12500					591
2500	210	153	118	79	52	13000					669
2600	223	161	123	82	54						
2700	233	167	128	86	56						
2800	241	173	132	89	58						
2900	250	181	137	92	60						
3000	260	187	142	96	62						
3100	277	197	148	100	66						
3200	288	204	153	103	67						
3300	296	210	159	107	70						

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI
100	307	8.0	254	8.0	217	8.0	205	8.0	166	8.0	3400	484	23.0	342	20.0	248	18.0	192	16.0
200	307	8.0	254	8.0	217	8.0	205	8.0	166	8.0	3500	499	24.0	353	21.0	257	18.0	197	17.0
300	307	8.0	254	8.0	217	8.0	205	8.0	166	8.0	3600	566	24.0	376	21.0	269	19.0	204	17.0
400	307	8.0	254	8.0	217	8.0	205	8.0	166	8.0	3700	583	25.0	385	22.0	275	19.0	208	18.0
500	270	8.0	254	8.0	217	8.0	205	8.0	166	8.0	3800	600	25.0	397	22.0	281	20.0	212	18.0
600	251	9.0	231	9.0	217	8.0	205	8.0	166	8.0	3900	620	26.0	407	23.0	288	20.0	216	18.0
700	239	9.0	218	9.0	201	9.0	186	8.0	166	8.0	4000	641	27.0	417	23.0	294	20.0	224	19.0
800	233	10.0	210	9.0	189	9.0	174	9.0	162	8.0	4500	772	31.0	500	26.0	337	23.0	251	20.0
900	233	10.0	205	10.0	183	9.0	165	9.0	152	8.0	5000			613	29.0	390	25.0	284	22.0
1000	234	11.0	203	10.0	180	10.0	159	9.0	144	9.0	5500					448	27.0	318	24.0
1100	244	11.0	208	11.0	180	10.0	157	10.0	139	9.0	6000					521	30.0	358	26.0
1200	250	12.0	212	11.0	180	11.0	155	10.0	136	9.0	6400					621	33.0	402	28.0
1300	257	13.0	216	12.0	179	11.0	154	10.0	134	10.0	7000					776	36.0	453	31.0
1400	265	13.0	220	12.0	183	11.0	154	11.0	132	10.0	7500							514	33.0
1500	275	14.0	225	13.0	186	12.0	155	11.0	132	10.0	8000							588	36.0
1600	297	14.0	239	13.0	192	12.0	159	11.0	133	11.0	8500							693	39.0
1700	308	15.0	246	14.0	198	13.0	161	11.0	134	11.0									
1800	319	15.0	253	14.0	203	13.0	164	12.0	134	11.0									
1900	331	16.0	261	15.0	208	13.0	167	12.0	137	12.0									
2000	344	16.0	271	15.0	213	14.0	170	13.0	138	12.0									
2100	377	17.0	288	16.0	224	14.0	176	13.0	142	12.0									
2200	392	18.0	298	16.0	230	15.0	179	13.0	145	13.0									
2300	408	18.0	309	17.0	242	15.0	183	14.0	150	13.0									
2400	422	19.0	318	17.0	245	16.0	187	14.0	152	13.0									
2500	439	19.0	328	18.0	251	16.0	192	15.0	155	13.0									
2600	498	20.0	356	18.0	264	16.0	201	15.0	160	14.0									
2700	515	21.0	366	19.0	273	17.0	207	15.0	163	14.0									
2800	535	21.0	377	19.0	282	17.0	212	16.0	167	14.0									
2900	555	22.0	391	20.0	290	18.0	218	16.0	171	15.0									
3000	575	23.0	402	20.0	297	18.0	222	16.0	174	15.0									
3100	727	24.0	441	21.0	314	19.0	232	17.0	182	15.0									
3200	750	24.0	454	21.0	325	19.0	237	17.0	184	16.0									
3300			468	22.0	333	20.0	243	18.0	188	16.0									

RAPID FIRE TABLE III

PROPELLANT WHITE BAG M4A2

WEAPON M114A1

FUZE M514

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3400	335	20.0	244	18.0	192	16.0	141	15.0	101	13.0
200	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3500	345	20.0	253	18.0	197	17.0	144	15.0	102	13.0
300	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3600	365	21.0	263	19.0	205	17.0	148	15.0	105	14.0
400	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3700	375	21.0	269	19.0	209	17.0	151	16.0	108	14.0
500	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3800	386	22.0	276	19.0	214	18.0	154	16.0	110	14.0
600	217	8.0	185	8.0	162	8.0	140	8.0	115	8.0	3900	396	22.0	284	20.0	219	18.0	158	16.0	111	14.0
700	200	9.0	162	8.0	162	8.0	140	8.0	115	8.0	4000	407	23.0	289	20.0	220	19.0	161	17.0	114	15.0
800	189	9.0	172	9.0	162	8.0	140	8.0	115	8.0	4500	482	25.0	331	22.0	251	20.0	183	18.0	126	16.0
900	182	9.0	166	9.0	152	8.0	140	8.0	115	8.0	5000	580	28.0	380	24.0	284	22.0	205	20.0	138	17.0
1000	174	10.0	159	9.0	144	9.0	130	8.0	115	8.0	5500	728	31.0	436	27.0	318	24.0	230	22.0	155	19.0
1100	179	10.0	156	10.0	139	9.0	124	8.0	115	8.0	6000			504	29.0	358	26.0	253	23.0	171	20.0
1200	178	10.0	154	10.0	136	9.0	119	9.0	109	8.0	6500			591	32.0	401	28.0	283	25.0	192	22.0
1300	179	11.0	153	10.0	135	10.0	115	9.0	105	8.0	7000			717	35.0	451	30.0	312	27.0	212	24.0
1400	183	11.0	152	11.0	134	10.0	112	9.0	100	9.0	7500					510	33.0	346	29.0	235	25.0
1500	185	12.0	151	11.0	133	10.0	110	9.0	97	9.0	8000					583	36.0	383	31.0	258	27.0
1600	191	12.0	156	11.0	134	11.0	109	10.0	95	9.0	8500					684	38.0	422	33.0	283	29.0
1700	195	12.0	160	12.0	135	11.0	108	10.0	93	9.0	9000					655	42.0	469	35.0	312	31.0
1800	201	13.0	163	12.0	136	11.0	108	10.0	92	9.0	9500							522	38.0	340	33.0
1900	206	13.0	165	12.0	138	12.0	108	10.0	91	10.0	10000							587	40.0	372	34.0
2000	210	14.0	168	13.0	139	12.0	108	11.0	90	10.0	10500							670	43.0	407	37.0
2100	222	14.0	174	13.0	143	12.0	110	11.0	90	10.0	11000							699	46.0	446	39.0
2200	230	14.0	177	13.0	146	12.0	113	11.0	90	10.0	11500									488	41.0
2300	234	15.0	181	14.0	148	13.0	114	12.0	90	10.0	12000									538	43.0
2400	242	15.0	187	14.0	151	13.0	116	12.0	90	11.0	12500									599	46.0
2500	248	16.0	191	14.0	156	13.0	117	12.0	90	11.0	13000									675	49.0
2600	261	16.0	199	15.0	161	14.0	120	12.0	92	11.0	13500									786	52.0
2700	269	17.0	203	15.0	164	14.0	122	13.0	92	11.0											
2800	276	17.0	208	15.0	167	14.0	124	13.0	93	12.0											
2900	284	17.0	215	16.0	171	15.0	126	13.0	94	12.0											
3000	292	18.0	219	16.0	174	15.0	128	14.0	94	12.0											
3100	308	18.0	228	17.0	179	15.0	131	14.0	97	12.0											
3200	318	19.0	234	17.0	183	16.0	133	14.0	98	13.0											
3300	325	19.0	239	17.0	188	16.0	136	14.0	99	13.0											

RAPID FIRE TABLE III**FUZE M728****PROPELLANT GREEN BAG M3A1****WEAPON M114A1**

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI
100	231	8.0	193	8.0	166	8.0	154	8.0	122	8.0	3400	475	23.0	333	20.0	239	18.0	183	16.0
200	231	8.0	193	8.0	166	8.0	154	8.0	122	8.0	3500	490	24.0	344	21.0	248	18.0	188	17.0
300	231	8.0	193	8.0	166	8.0	154	8.0	122	8.0	3600	557	24.0	367	21.0	260	19.0	195	17.0
400	231	8.0	193	8.0	166	8.0	154	8.0	122	8.0	3700	575	25.0	375	22.0	267	19.0	200	18.0
500	209	8.0	193	8.0	166	8.0	154	8.0	122	8.0	3800	592	25.0	389	22.0	273	20.0	204	18.0
600	200	9.0	180	9.0	166	8.0	154	8.0	122	8.0	3900	612	26.0	399	23.0	280	20.0	208	18.0
700	195	9.0	174	9.0	157	9.0	142	8.0	122	8.0	4000	633	27.0	409	23.0	286	20.0	216	19.8
800	195	10.0	172	9.0	151	9.0	136	9.0	124	8.0	4500	765	31.0	493	26.0	330	23.0	244	20.0
900	200	10.0	172	10.0	150	9.0	132	9.0	119	8.0	5000			607	29.0	384	25.0	278	22.0
1000	204	11.0	173	10.0	150	10.0	129	9.0	114	9.0	5500					442	27.0	312	24.0
1100	216	11.0	180	11.0	152	10.0	129	10.0	111	9.0	6000					416	30.0	353	26.0
1200	225	12.0	187	11.0	155	11.0	130	10.0	111	9.0	6400					616	33.0	397	28.0
1300	233	13.0	192	12.0	155	11.0	130	10.0	110	10.0	7000					771	36.0	449	31.0
1400	243	13.0	198	12.0	161	11.0	132	11.0	110	10.0	7500							510	33.0
1500	255	14.0	205	13.0	166	12.0	135	11.0	112	10.0	8000							584	36.0
1600	278	14.0	220	13.0	173	12.0	140	11.0	114	11.0	8500							690	39.0
1700	290	15.0	228	14.0	180	13.0	143	11.0	116	11.0									
1800	302	15.0	244	14.0	186	13.0	147	12.0	117	11.0									
1900	315	16.0	245	15.0	192	13.0	151	12.0	121	12.0									
2000	329	16.0	256	15.0	198	14.0	155	13.0	123	12.0									
2100	362	17.0	273	16.0	209	14.0	161	13.0	127	12.0									
2200	378	18.0	284	16.0	216	15.0	165	13.0	131	13.0									
2300	395	18.0	296	17.0	229	15.0	170	14.0	137	13.0									
2400	409	19.0	305	17.0	232	16.0	174	14.0	139	13.0									
2500	427	19.0	316	18.0	239	16.0	180	15.0	143	13.0									
2600	486	20.0	344	18.0	252	16.0	189	15.0	148	14.0									
2700	504	21.0	355	19.0	262	17.0	196	15.0	152	14.0									
2800	524	21.0	366	19.0	271	17.0	201	16.0	156	14.0									
2900	544	22.0	380	20.0	279	18.0	207	16.0	160	15.0									
3000	565	23.0	392	20.0	287	18.0	212	16.0	164	15.0									
3100	718	24.0	432	21.0	305	19.0	223	17.0	173	15.0									
3200	741	24.0	445	21.0	316	19.0	228	17.0	175	16.0									
3300			459	22.0	324	20.0	234	18.0	179	16.0									

NOTE: No restrictions.

RAPID FIRE TABLE III

FUZE M728

PROPELLANT WHITE BAG M4A2

WEAPON M114A1

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	166	8.0	134	8.0	124	8.0	107	8.0	87	8.0	3400	326	20.0	235	18.0	183	16.0	132	15.0	92	13.0
200	166	8.0	134	8.0	124	8.0	107	8.0	87	8.0	3500	336	20.0	244	18.0	188	17.0	135	15.0	93	13.0
300	166	8.0	134	8.0	124	8.0	107	8.0	87	8.0	3600	356	21.0	254	19.0	196	17.0	139	15.0	96	14.0
400	166	8.0	134	8.0	124	8.0	107	8.0	87	8.0	3700	367	21.0	261	19.0	201	17.0	143	16.0	100	14.0
500	166	8.0	134	8.0	124	8.0	107	8.0	87	8.0	3800	378	22.0	268	19.0	206	18.0	146	16.0	102	14.0
600	166	8.0	134	8.0	124	8.0	107	8.0	87	8.0	3900	383	22.0	276	20.0	211	18.0	150	16.0	103	14.0
700	156	9.0	134	8.0	124	8.0	107	8.0	87	8.0	4000	399	23.0	281	20.0	212	19.0	153	17.0	106	15.0
800	151	9.0	134	9.0	124	8.0	107	8.0	87	8.0	4500	475	25.0	224	22.0	244	20.0	176	18.0	119	16.0
900	149	9.0	133	9.0	119	8.0	107	8.0	87	8.0	5000	574	28.0	374	24.0	278	22.0	199	20.0	132	17.0
1000	149	10.0	129	9.0	114	9.0	100	8.0	87	8.0	5500	722	31.0	430	27.0	212	24.0	224	22.0	149	19.0
1100	151	10.0	128	10.0	111	9.0	96	8.0	87	8.0	6000	499	29.0	499	29.0	353	26.0	243	23.0	166	20.0
1200	153	10.0	129	10.0	111	9.0	94	9.0	84	8.0	6500	586	32.0	586	32.0	396	28.0	278	25.0	187	22.0
1300	155	11.0	129	10.0	111	10.0	91	9.0	81	8.0	7000	713	35.0	713	35.0	447	30.0	308	27.0	203	24.0
1400	161	11.0	130	11.0	112	10.0	90	9.0	78	9.0	7500					506	33.0	342	29.0	231	25.0
1500	165	12.0	133	11.0	113	10.0	90	9.0	77	9.0	8000					579	36.0	379	31.0	254	27.0
1600	172	12.0	137	11.0	115	11.0	90	10.0	76	9.0	8500					681	38.0	419	33.0	280	29.0
1700	177	12.0	142	12.0	117	11.0	90	10.0	75	9.0	9000					652	42.0	466	35.0	309	31.0
1800	184	13.0	146	12.0	119	11.0	91	10.0	75	9.0	9500							519	38.0	337	33.0
1900	190	13.0	149	12.0	122	12.0	92	10.0	75	10.0	10000							584	40.0	369	34.0
2000	195	14.0	153	13.0	124	12.0	93	11.0	75	10.0	10500							667	43.0	404	37.0
2100	207	14.0	159	13.0	128	12.0	95	11.0	75	10.0	11000							696	46.0	443	39.0
2200	216	14.0	163	13.0	132	12.0	99	11.0	76	10.0	11500									486	41.0
2300	221	15.0	168	14.0	135	13.0	101	12.0	77	10.0	12000									535	43.0
2400	229	15.0	174	14.0	138	13.0	103	12.0	77	11.0	12500									596	46.0
2500	236	16.0	178	14.0	144	13.0	105	12.0	78	11.0	13000									673	49.0
2600	249	16.0	187	15.0	149	14.0	108	12.0	80	11.0	13500									784	52.0
2700	258	17.0	192	15.0	153	14.0	111	13.0	81	11.0											
2800	265	17.0	197	15.0	156	14.0	113	13.0	82	12.0											
2900	273	17.0	204	16.0	160	15.0	115	13.0	83	12.0											
3000	282	18.0	209	16.0	164	15.0	118	14.0	84	12.0											
3100	299	18.0	219	17.0	170	15.0	122	14.0	88	12.0											
3200	309	19.0	225	17.0	174	16.0	124	14.0	89	13.0											
3300	316	19.0	230	17.0	179	16.0	127	14.0	90	13.0											

NOTE: No restrictions.

RAPID FIRE TABLE IV

FUZE M557, M564

PROPELLANT GREEN BAG M3A1 WEAPON M109/M114A2

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	Range to Crest	CHG 2	CHG 3	CHG 4	CHG 5
100	67	63	61	59	57	3300	430	278	201	157
200	53	47	43	39	36	3400	444	287	206	162
300	56	48	40	36	30	3500	460	298	216	167
400	63	53	43	37	30	3600	521	318	227	175
500	75	60	48	40	32	3700	538	327	234	180
600	89	71	53	43	35	3800	556	336	240	185
700	101	79	59	47	38	3900	574	347	247	191
800	114	88	65	51	41	4000	594	357	254	196
900	125	96	71	55	44	4500		428	296	227
1000	138	106	78	61	48	5000		507	343	261
1100	157	119	85	66	51	5500		638	395	295
1200	170	129	92	71	55	6000			460	335
1300	182	138	98	76	58	6500			528	378
1400	197	148	107	81	63	7000			642	427
1500	211	160	114	86	69	7500				485
1600	237	176	124	93	73	8000				557
1700	250	185	131	97	76	8500				651
1800	266	196	138	103	81					
1900	280	208	145	108	85					
2000	297	219	153	114	90					
2100	331	238	164	123	95					
2200	348	251	172	128	100					
2300	365	262	182	136	105					
2400	381	273	189	142	110					
2500	400	286	197	148	114					
2600	457	311	210	155	119					
2700	476	325	218	160	124					
2800	497	337	226	166	129					
2900	517	351	234	173	134					
3000	539	364	245	179	141					
3100	681	401	261	189	147					
3200	705	414	269	195	152					

RAPID FIRE TABLE IV

FUZE M557, M564

PROPELLANT WHITE BAG M4A2 WEAPON M109/M114A2

Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	61	60	57	56	55	3500	324	224	170	116	76
200	43	40	36	33	32	3600	345	236	178	121	78
300	41	36	30	27	24	3700	355	243	183	125	81
400	44	37	30	25	22	3800	367	249	188	129	83
500	49	40	32	26	22	3900	377	258	194	133	86
600	55	43	35	27	21	4000	389	265	199	137	89
700	63	48	38	29	22	4500	470	309	230	162	106
800	69	52	41	30	23	5000	577	360	265	186	121
900	76	56	44	32	23	5500		414	298	210	138
1000	81	62	48	34	25	6000		483	339	238	158
1100	91	69	51	36	27	6500		567	383	267	180
1200	100	74	56	39	29	7000		686	432	297	202
1300	107	79	59	41	30	7500			492	332	226
1400	114	84	63	43	31	8000			565	367	248
1500	122	90	68	46	33	8500			664	408	278
1600	134	97	75	49	35	9000				453	303
1700	141	102	78	51	36	9500				506	340
1800	149	108	83	54	38	10000				569	367
1900	156	113	88	57	40	10500				651	408
2000	166	121	92	60	42	11000					440
2100	178	129	98	64	44	11500					497
2200	186	135	103	68	46	12000					535
2300	194	140	107	71	48	12500					628
2400	204	146	112	74	50	13000					673
2500	213	152	117	77	52						
2600	227	160	122	83	54						
2700	237	168	127	86	56						
2800	246	174	132	90	58						
2900	255	180	137	93	60						
3000	265	187	142	97	63						
3100	283	196	147	101	66						
3200	292	202	153	104	68						
3300	303	211	160	108	71						
3400	313	217	165	112	73						

RAPID FIRE TABLE IV **FUZE M514 PROPELLANT WHITE BAG M4A2**

WEAPON M109/M114A2

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3400	341	20.0	249	16.0	193	16.0	140	15.0	101	13.0
200	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3500	352	20.0	252	17.0	198	17.0	144	15.0	104	13.0
300	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3600	372	21.0	263	17.0	205	17.0	148	15.0	105	14.0
400	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3700	391	21.0	269	18.0	209	18.0	151	16.0	107	14.0
500	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3800	392	22.0	274	18.0	213	18.0	154	16.0	108	14.0
600	216	8.0	186	8.0	176	8.0	140	8.0	115	8.0	3900	402	22.0	283	18.0	219	18.0	158	16.0	111	14.0
700	201	9.0	186	8.0	176	8.0	140	8.0	115	8.0	4000	413	23.0	289	19.0	223	19.0	161	17.0	113	15.0
800	190	9.0	173	8.0	162	8.0	140	8.0	115	8.0	4500	491	23.0	330	20.0	251	20.0	183	18.0	127	16.0
900	184	9.0	164	8.0	152	8.0	140	8.0	115	8.0	5000	596	24.0	379	22.0	284	22.0	205	20.0	140	17.0
1000	177	10.0	158	9.0	144	9.0	130	8.0	115	8.0	5500			432	24.0	316	24.0	228	22.0	156	19.0
1100	179	10.0	157	9.0	139	9.0	124	8.0	115	8.0	6000			499	26.0	355	26.0	254	24.0	174	21.0
1200	180	11.0	154	9.0	136	9.0	119	9.0	109	8.0	6500			581	28.0	398	30.0	282	25.0	195	22.0
1300	182	11.0	154	10.0	134	10.0	116	9.0	105	8.0	7000			700	30.0	446	30.0	311	27.0	216	24.0
1400	183	11.0	153	10.0	132	10.0	112	9.0	100	9.0	7500					505	33.0	345	29.0	239	26.0
1500	186	12.0	154	10.0	132	10.0	110	9.0	97	9.0	8000					577	35.0	379	31.0	260	27.0
1600	194	12.0	157	11.0	135	11.0	109	10.0	95	9.0	8500					675	38.0	419	33.0	289	29.0
1700	198	13.0	159	11.0	135	11.0	108	10.0	93	9.0	9000							464	35.0	314	31.0
1800	203	13.0	162	11.0	137	11.0	108	10.0	92	9.0	9500							516	38.0	350	33.0
1900	207	13.0	164	12.0	139	12.0	108	11.0	91	10.0	10000							579	40.0	378	35.0
2000	214	14.0	169	12.0	140	12.0	108	11.0	90	10.0	10500							660	43.0	417	37.0
2100	224	14.0	175	12.0	144	12.0	110	11.0	90	10.0	11000									449	39.0
2200	236	15.0	179	13.0	147	13.0	112	11.0	90	10.0	11500									503	41.0
2300	236	15.0	182	13.0	149	13.0	113	12.0	90	11.0	12000									543	44.0
2400	244	16.0	186	13.0	152	13.0	114	12.0	90	11.0	12500									636	46.0
2500	253	16.0	190	13.0	155	13.0	115	12.0	90	11.0	13000									680	49.0
2600	265	16.0	198	14.0	160	14.0	121	12.0	92	11.0											
2700	273	17.0	204	14.0	163	14.0	122	13.0	92	11.0											
2800	281	17.0	209	14.0	167	14.0	125	13.0	93	12.0											
2900	289	18.0	214	15.0	171	15.0	127	13.0	94	12.0											
3000	297	18.0	219	15.0	174	15.0	129	14.0	95	12.0											
3100	314	18.0	227	15.0	178	15.0	132	14.0	97	12.0											
3200	322	19.0	232	16.0	183	16.0	134	14.0	98	13.0											
3300	332	19.0	240	16.0	189	16.0	137	15.0	100	13.0											

RAPID FIRE TABLE IV

Range to Crest	FUZE M728						PROPELLANT GREEN BAG M3A1						WEAPON M109/M114A2									
	CHG		CHG		CHG		CHG		CHG		Range to Crest	CHG		CHG		CHG		CHG				
	1	2	1	2	1	2	1	2	1	2		1	2	1	2	1	2	1	2			
100	207	8.0	192	8.0	163	8.0	141	8.0	124	8.0	3400	463	22.0	306	19.0	225	18.0	181	16.0			
200	207	8.0	192	8.0	163	8.0	141	8.0	124	8.0	3500	479	23.0	317	20.0	235	18.0	186	17.0			
300	207	8.0	192	8.0	163	8.0	141	8.0	124	8.0	3600	539	24.0	336	20.0	245	18.0	193	17.0			
400	207	8.0	192	8.0	163	8.0	141	8.0	124	8.0	3700	556	24.0	345	21.0	252	19.0	198	18.0			
500	207	8.0	192	8.0	163	8.0	141	8.0	124	8.0	3800	573	25.0	353	21.0	257	19.0	202	18.0			
600	199	9.0	181	9.0	163	8.0	141	8.0	124	8.0	3900	591	26.0	364	22.0	264	20.0	208	18.0			
700	195	9.0	173	9.0	153	9.0	141	8.0	124	8.0	4000	610	26.0	373	22.0	270	20.0	212	19.0			
800	197	10.0	171	9.0	148	9.0	134	9.0	124	8.0	4500			442	25.0	310	22.0	241	20.0			
900	200	10.0	171	10.0	146	9.0	130	9.0	119	8.0	5000			520	28.0	356	24.0	274	22.0			
1000	204	11.0	172	10.0	144	10.0	127	9.0	114	9.0	5500			650	31.0	407	26.0	307	24.0			
1100	217	11.0	179	11.0	145	10.0	126	10.0	111	9.0	6000					471	29.0	346	26.0			
1200	225	12.0	184	11.0	147	10.0	126	10.0	110	9.0	6500					538	31.0	388	28.0			
1300	233	12.0	189	12.0	149	11.0	127	10.0	109	10.0	7000					652	34.0	437	30.0			
1400	244	13.0	195	12.0	154	11.0	128	11.0	110	10.0	7500							494	33.0			
1500	255	14.0	203	13.0	158	12.0	130	11.0	113	10.0	8000							565	35.0			
1600	278	14.0	217	13.0	165	12.0	134	11.0	114	11.0	8500							659	38.0			
1700	289	15.0	224	14.0	170	12.0	136	12.0	115	11.0												
1800	303	15.0	233	14.0	175	13.0	140	12.0	118	11.0												
1900	315	16.0	243	14.0	180	13.0	143	12.0	120	12.0												
2000	330	16.0	252	15.0	186	14.0	147	13.0	123	12.0												
2100	362	17.0	269	15.0	195	14.0	154	13.0	126	12.0												
2200	378	18.0	281	16.0	202	14.0	158	13.0	130	13.0												
2300	394	18.0	291	16.0	211	15.0	165	14.0	134	13.0												
2400	408	19.0	300	17.0	216	15.0	169	14.0	137	13.0												
2500	426	19.0	312	17.0	223	16.0	174	14.0	140	13.0												
2600	483	20.0	337	18.0	236	16.0	181	15.0	145	14.0												
2700	501	21.0	350	18.0	243	16.0	185	15.0	149	14.0												
2800	521	21.0	361	19.0	250	17.0	190	15.0	153	14.0												
2900	540	22.0	374	20.0	257	17.0	196	16.0	157	15.0												
3000	561	23.0	386	20.0	267	18.0	201	16.0	163	15.0												
3100	703	24.0	423	21.0	283	18.0	211	16.0	169	15.0												
3200	726	24.0	435	21.0	290	19.0	216	17.0	173	16.0												
3300	754	25.0	450	22.0	298	19.0	221	17.0	177	16.0												

NOTE: No restrictions.

RAPID FIRE TABLE IV **PROPELLANT WHITE BAG M4A2**

FUZE M728

WEAPON M109/M114A2

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	165	8.0	142	8.0	132	8.0	107	8.0	87	8.0	3400	332	20.0	236	16.0	184	16.0	131	15.0	92	13.0
200	165	8.0	142	8.0	132	8.0	107	8.0	87	8.0	3500	343	20.0	243	17.0	189	17.0	135	15.0	95	13.0
300	165	8.0	142	8.0	132	8.0	107	8.0	87	8.0	3600	363	21.0	254	17.0	196	17.0	139	15.0	96	14.0
400	165	8.0	142	8.0	132	8.0	107	8.0	87	8.0	3700	373	21.0	261	18.0	201	18.0	143	16.0	99	14.0
500	165	8.0	142	8.0	132	8.0	107	8.0	87	8.0	3800	384	22.0	266	18.0	205	18.0	146	16.0	100	14.0
600	165	8.0	142	8.0	132	8.0	107	8.0	87	8.0	3900	394	22.0	275	18.0	211	18.0	150	16.0	103	14.0
700	157	9.0	142	8.0	132	8.0	107	8.0	87	8.0	4000	405	23.0	281	19.0	215	19.0	153	17.0	105	15.0
800	152	9.0	135	8.0	124	8.0	107	8.0	87	8.0	4500	484	23.0	323	20.0	244	20.0	176	18.0	120	16.0
900	151	9.0	131	8.0	119	8.0	107	8.0	87	8.0	5000	590	24.0	373	22.0	278	22.0	199	20.0	134	17.0
1000	147	10.0	128	9.0	114	9.0	100	8.0	87	8.0	5500			426	24.0	310	24.0	222	22.0	150	19.0
1100	151	10.0	129	9.0	111	9.0	96	8.0	87	8.0	6000			494	26.0	350	26.0	249	24.0	169	21.0
1200	155	11.0	129	9.0	111	9.0	94	9.0	84	8.0	6500			576	28.0	393	30.0	277	25.0	190	22.0
1300	158	11.0	130	10.0	110	10.0	92	9.0	81	8.0	7000			696	30.0	442	30.0	307	27.0	212	24.0
1400	161	11.0	131	10.0	110	10.0	90	9.0	78	9.0	7500					501	33.0	341	29.0	235	26.0
1500	166	12.0	134	10.0	112	10.0	90	9.0	77	9.0	8000					573	35.0	375	31.0	256	27.0
1600	175	12.0	138	11.0	116	11.0	90	10.0	76	9.0	8500					672	38.0	416	33.0	286	29.0
1700	180	13.0	141	11.0	117	11.0	90	10.0	75	9.0	9000							461	35.0	311	31.0
1800	186	13.0	145	11.0	120	11.0	91	10.0	75	9.0	9500							513	38.0	347	33.0
1900	191	13.0	148	12.0	123	12.0	92	11.0	75	10.0	10000							576	40.0	375	35.0
2000	199	14.0	154	12.0	125	12.0	93	11.0	75	10.0	10500							657	43.0	414	37.0
2100	209	14.0	160	12.0	129	12.0	95	11.0	75	10.0	11000									446	39.0
2200	216	15.0	165	13.0	133	13.0	98	11.0	76	10.0	11500									501	41.0
2300	223	15.0	164	13.0	136	13.0	100	12.0	77	11.0	12000									540	43.0
2400	231	16.0	173	13.0	139	13.0	101	12.0	77	11.0	12500									633	46.0
2500	239	16.0	178	13.0	143	13.0	103	12.0	78	11.0	13000									678	49.0
2600	253	16.0	186	14.0	148	14.0	109	12.0	80	11.0											
2700	262	17.0	193	14.0	152	14.0	111	13.0	81	11.0											
2800	270	17.0	198	14.0	156	14.0	114	13.0	82	12.0											
2900	278	18.0	203	15.0	160	15.0	116	13.0	83	12.0											
3000	287	18.0	209	15.0	164	15.0	119	14.0	85	12.0											
3100	305	18.0	218	15.0	169	15.0	123	14.0	88	12.0											
3200	313	19.0	223	16.0	174	16.0	125	14.0	89	13.0											
3300	323	19.0	231	16.0	180	16.0	128	15.0	91	13.0											

NOTE: No restrictions.

RAPID FIRE TABLE V

FUZE M557, M564

PROPELLANT GREEN BAG M3A1

WEAPON M109A1

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5
100	66	65	61	59	57	3300	669	415	274	199	157
200	52	49	43	39	36	3400	697	431	282	207	162
300	56	49	40	35	30	3500	728	447	293	213	167
400	63	54	43	36	30	3600		501	313	224	174
500	75	61	47	39	32	3700		517	322	231	179
600	87	70	53	42	35	3800		534	331	237	184
700	100	78	59	47	38	3900		552	342	244	189
800	113	87	64	51	41	4000		571	351	250	195
900	123	95	70	55	44	4500			420	292	227
1000	137	104	77	60	48	5000			504	338	260
1100	154	118	84	65	51	5500			620	389	293
1200	168	127	91	70	55	6000				451	332
1300	182	136	97	75	58	6500				525	375
1400	194	145	104	80	62	7000				625	424
1500	209	155	113	85	67	7500					481
1600	233	171	123	92	72	8000					551
1700	247	182	129	96	76	8500					643
1800	261	192	136	102	80						
1900	276	202	144	107	85						
2000	292	213	151	113	89						
2100	324	233	162	121	95						
2200	341	244	170	129	99						
2300	357	255	179	135	104						
2400	374	266	187	140	109						
2500	391	279	195	146	116						
2600	440	302	206	153	120						
2700	460	313	214	159	125						
2800	478	327	222	164	130						
2900	500	339	232	170	135						
3000	519	353	240	176	140						
3100	619	388	257	186	147						
3200	645	402	265	192	152						

NOTE: CHG 1 restriction due to possibility of a "sticker" (see TM 9-2350-217-10N).

RAPID FIRE TABLE V

FUZE M557, M564

PROPELLANT WHITE BAG M4A2 (CHG 3-7), M119 (CHG 8)

WEAPON M109A1

Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	CHG 8	Range to Crest	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7	CHG 8
100	58	58	57	56	55	53	3300	257	185	148	101	69	47
200	41	37	35	33	32	29	3400	264	191	153	105	72	49
300	38	33	29	26	24	21	3500	272	197	158	109	74	50
400	40	33	29	25	22	18	3600	288	205	164	113	77	52
500	44	36	30	25	21	17	3700	296	211	169	117	79	54
600	50	40	33	26	21	16	3800	306	217	174	121	82	55
700	55	43	35	28	22	16	3900	314	223	181	124	84	57
800	60	47	38	29	22	16	4000	324	231	186	128	87	59
900	65	51	40	30	23	16	4500	383	267	215	152	103	67
1000	73	56	44	33	25	18	5000	450	307	244	175	118	78
1100	80	62	47	34	27	18	5500	534	349	278	197	136	88
1200	87	67	51	37	28	19	6000	645	401	312	225	154	99
1300	94	71	54	39	29	19	6500		458	352	251	175	111
1400	100	76	58	41	31	20	7000		531	396	280	194	125
1500	106	81	64	44	33	22	7500		617	446	313	220	138
1600	117	87	69	47	35	23	8000			503	346	241	154
1700	122	91	72	48	36	23	8500			575	384	269	171
1800	129	96	76	51	38	24	9000			671	423	295	189
1900	135	101	80	54	40	26	9500				470	326	208
2000	144	106	84	57	41	27	10000				525	355	229
2100	153	112	90	61	43	31	10500				591	394	250
2200	160	120	94	64	45	33	11000				680	425	272
2300	169	125	98	67	48	34	11500					478	299
2400	175	130	103	70	50	35	12000					512	323
2500	182	135	107	73	52	37	12500					595	352
2600	194	142	114	76	53	37	13000					636	379
2700	201	147	119	81	55	39	13500						418
2800	210	152	123	84	57	40	14000						445
2900	217	158	128	88	59	41	14500						493
3000	225	163	133	91	62	43	15000						525
3100	240	172	138	94	65	44	15500						596
3200	247	180	143	98	67	46	16000						635

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI
100	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3600	528	23.0	340	20.0	251	18.0	201	17.0
200	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3700	543	24.0	348	21.0	257	19.0	205	17.0
300	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3800	559	25.0	356	21.0	262	19.0	209	18.0
400	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	3900	577	25.0	367	22.0	269	19.0	214	18.0
500	268	8.0	254	8.0	214	8.0	185	8.0	162	8.0	4000	595	26.0	375	22.0	274	20.0	219	18.0
600	248	9.0	231	9.0	214	8.0	185	8.0	162	8.0	4500			441	25.0	313	22.0	248	20.0
700	238	9.0	216	9.0	197	9.0	185	8.0	162	8.0	5000			523	27.0	357	24.0	278	22.0
800	234	10.0	208	9.0	185	9.0	172	9.0	162	8.0	5500			638	30.0	407	26.0	311	24.0
900	231	10.0	203	10.0	178	9.0	163	9.0	152	8.0	6000					467	29.0	348	26.0
1000	233	11.0	200	10.0	173	10.0	156	9.0	144	9.0	6500					540	31.0	390	28.0
1100	242	11.0	206	11.0	172	10.0	153	9.0	139	9.0	7000					639	34.0	438	30.0
1200	248	12.0	207	11.0	171	10.0	150	10.0	135	9.0	7500							494	33.0
1300	257	12.0	211	12.0	172	11.0	150	10.0	133	10.0	8000							563	35.0
1400	261	13.0	214	12.0	173	11.0	149	10.0	131	10.0	8500							654	38.0
1500	273	13.0	219	12.0	177	12.0	149	11.0	131	10.0									
1600	293	14.0	231	13.0	183	12.0	152	11.0	132	11.0									
1700	304	14.0	239	13.0	186	12.0	153	11.0	133	11.0									
1800	315	15.0	246	14.0	190	13.0	156	12.0	134	11.0									
1900	327	15.0	253	14.0	195	13.0	158	12.0	136	12.0									
2000	340	16.0	261	15.0	199	13.0	161	13.0	137	12.0									
2100	370	17.0	279	15.0	208	14.0	167	13.0	141	12.0									
2200	385	17.0	288	16.0	214	14.0	173	13.0	143	12.0									
2300	399	18.0	297	16.0	221	15.0	177	14.0	146	13.0									
2400	414	18.0	306	17.0	227	15.0	180	14.0	149	13.0									
2500	429	19.0	317	17.0	233	16.0	184	14.0	154	13.0									
2600	478	20.0	340	18.0	244	16.0	191	15.0	158	14.0									
2700	496	20.0	349	18.0	250	16.0	195	15.0	161	14.0									
2800	511	21.0	362	19.0	257	17.0	199	15.0	165	14.0									
2900	534	21.0	373	19.0	266	17.0	204	16.0	169	15.0									
3000	551	22.0	385	20.0	272	18.0	208	16.0	172	15.0									
3100	600	23.0	419	20.0	288	18.0	217	16.0	178	15.0									
3200	675	24.0	432	21.0	295	18.0	222	17.0	182	16.0									
3300	698	24.0	444	22.0	303	19.0	228	17.0	186	16.0									
3400	725	25.0	459	22.0	310	19.0	235	18.0	190	16.0									
3500	756	26.0	475	23.0	321	20.0	241	18.0	195	17.0									

RAPID FIRE TABLE V

FUZE M514

PROPELLANT WHITE BAG
M4A2 (CHG 3-7), M119 (CHG 8)

WEAPON M109A1

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		CHG 8	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
200	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
300	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
400	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
500	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
600	211	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
700	193	8.0	181	8.0	159	8.0	138	8.0	115	8.0	94	8.0
800	181	9.0	168	8.0	159	8.0	138	8.0	115	8.0	94	8.0
900	173	9.0	159	9.0	148	8.0	138	8.0	115	8.0	94	8.0
1000	169	9.0	152	9.0	140	9.0	129	8.0	115	8.0	94	8.0
1100	168	10.0	150	9.0	135	9.0	122	8.0	115	8.0	94	8.0
1200	167	10.0	147	10.0	131	9.0	117	9.0	108	8.0	94	8.0
1300	169	11.0	146	10.0	129	9.0	114	9.0	104	8.0	94	8.0
1400	169	11.0	145	10.0	127	10.0	110	9.0	100	9.0	89	8.0
1500	170	11.0	145	11.0	128	10.0	108	9.0	97	9.0	86	8.0
1600	177	12.0	147	11.0	129	10.0	107	10.0	95	9.0	83	8.0
1700	179	12.0	148	11.0	129	11.0	105	10.0	93	9.0	80	9.0
1800	183	12.0	150	12.0	130	11.0	105	10.0	92	9.0	78	9.0
1900	186	13.0	152	12.0	131	11.0	105	10.0	91	10.0	77	9.0
2000	192	13.0	154	12.0	132	12.0	105	11.0	89	10.0	77	9.0
2100	199	13.0	156	13.0	136	12.0	107	11.0	89	10.0	77	9.0
2200	204	14.0	164	13.0	138	12.0	108	11.0	89	10.0	77	9.0
2300	211	14.0	167	13.0	140	13.0	109	11.0	90	10.0	76	10.0
2400	215	15.0	170	14.0	143	13.0	110	12.0	90	11.0	75	10.0
2500	220	15.0	173	14.0	145	13.0	111	12.0	90	11.0	75	10.0
2600	232	15.0	180	14.0	152	13.0	114	12.0	91	11.0	75	10.0
2700	237	16.0	183	15.0	155	14.0	117	12.0	91	11.0	75	10.0
2800	245	16.0	187	15.0	158	14.0	119	13.0	92	12.0	75	11.0
2900	251	17.0	192	15.0	162	14.0	122	13.0	93	12.0	75	11.0
3000	257	17.0	195	16.0	165	15.0	123	13.0	94	12.0	75	11.0
3100	271	17.0	203	16.0	169	15.0	125	14.0	96	12.0	75	11.0
3200	277	18.0	210	16.0	173	15.0	128	14.0	97	13.0	76	11.0

RAPID FIRE TABLE V

FUZE M514

PROPELLANT WHITE BAG
M4A2 (CHG 3-7), M119 (CHG 8)

WEAPON M109A1

[illegible]

RAPID FIRE TABLE V

FUZE M728

PROPELLANT GREEN BAG M3A1

WEAPON M109A1

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI
100	207	8.0	193	8.0	163	8.0	141	8.0	124	8.0	3600	519	23.0	331	20.0	242	18.0	192	17.0
200	207	8.0	193	8.0	163	8.0	141	8.0	124	8.0	3700	535	24.0	340	21.0	249	19.0	197	17.0
300	207	8.0	193	8.0	163	8.0	141	8.0	124	8.0	3800	551	25.0	348	21.0	254	19.0	201	18.0
400	207	8.0	193	8.0	163	8.0	141	8.0	124	8.0	3900	569	25.0	359	22.0	261	19.0	206	18.0
500	207	8.0	193	8.0	163	8.0	141	8.0	124	8.0	4000	587	26.0	367	22.0	266	20.0	211	18.0
600	197	9.0	180	9.0	163	8.0	141	8.0	124	8.0	4500			434	25.0	306	22.0	241	20.0
700	194	9.0	172	9.0	153	9.0	141	8.0	124	8.0	5000			517	27.0	351	24.0	272	22.0
800	196	10.0	170	9.0	147	9.0	134	9.0	124	8.0	5500			632	30.0	401	26.0	305	24.0
900	198	10.0	170	10.0	145	9.0	130	9.0	119	8.0	6000					462	29.0	343	26.0
1000	203	11.0	170	10.0	143	10.0	126	9.0	114	9.0	6500					535	31.0	385	28.0
1100	214	11.0	178	11.0	144	10.0	125	9.0	111	9.0	7000					635	34.0	434	30.0
1200	223	12.0	182	11.0	146	10.0	125	10.0	110	9.0	7500							490	33.0
1300	233	12.0	187	12.0	148	11.0	126	10.0	109	10.0	8000							559	35.0
1400	241	13.0	192	12.0	151	11.0	127	10.0	109	10.0	8500							651	38.0
1500	253	13.0	199	12.0	157	12.0	129	11.0	111	10.0									
1600	274	14.0	212	13.0	164	12.0	133	11.0	113	11.0									
1700	286	14.0	221	13.0	168	12.0	135	11.0	115	11.0									
1800	298	15.0	229	14.0	173	13.0	139	12.0	117	11.0									
1900	311	15.0	237	14.0	179	13.0	142	12.0	120	12.0									
2000	325	16.0	246	15.0	184	13.0	146	13.0	122	12.0									
2100	355	17.0	264	15.0	193	14.0	152	13.0	126	12.0									
2200	371	17.0	274	16.0	200	14.0	159	13.0	129	12.0									
2300	386	18.0	284	16.0	208	15.0	164	14.0	133	13.0									
2400	401	18.0	293	17.0	214	15.0	167	14.0	136	13.0									
2500	417	19.0	305	17.0	221	16.0	172	14.0	142	13.0									
2600	466	20.0	328	18.0	232	16.0	179	15.0	146	14.0									
2700	485	20.0	338	18.0	239	16.0	184	15.0	150	14.0									
2800	502	21.0	351	19.0	246	17.0	188	15.0	154	14.0									
2900	523	21.0	362	19.0	255	17.0	193	16.0	158	15.0									
3000	541	22.0	375	20.0	262	18.0	198	16.0	162	15.0									
3100	641	23.0	410	20.0	279	18.0	208	16.0	169	15.0									
3200	655	24.0	423	21.0	286	18.0	213	17.0	173	16.0									
3300	689	24.0	435	22.0	294	19.0	219	17.0	177	16.0									
3400	716	25.0	450	22.0	301	19.0	226	18.0	181	16.0									
3500	747	26.0	466	23.0	312	20.0	232	18.0	186	17.0									

NOTE: CHG 1 restriction due to possibility of a "sticker" (see TM 9-2350-217-10N).

RAPID FIRE TABLE V **PROPELLANT WHITE BAG** **M4A2 (CHG 3-7), M119 (CHG 8)**

WEAPON M109A1

Range to Crest	FUZE M728		CHG		CHG		CHG		CHG		CHG		CHG		CHG	
	3		4		5		6		7		8		8		8	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	160	8.0	137	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
200	160	8.0	137	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
300	160	8.0	137	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
400	160	8.0	137	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
500	160	8.0	137	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
600	160	8.0	137	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
700	149	8.0	137	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
800	143	9.0	130	8.0	121	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
900	140	9.0	126	9.0	113	8.0	105	8.0	87	8.0	70	8.0	70	8.0	70	8.0
1000	139	9.0	122	9.0	110	9.0	99	8.0	87	8.0	70	8.0	70	8.0	70	8.0
1100	140	10.0	122	9.0	107	9.0	94	8.0	87	8.0	70	8.0	70	8.0	70	8.0
1200	142	10.0	122	10.0	106	9.0	92	9.0	83	8.0	70	8.0	70	8.0	70	8.0
1300	145	11.0	122	10.0	105	9.0	90	9.0	80	8.0	70	8.0	70	8.0	70	8.0
1400	147	11.0	123	10.0	105	10.0	88	9.0	78	9.0	67	8.0	67	8.0	67	8.0
1500	150	11.0	125	11.0	108	10.0	88	9.0	77	9.0	66	8.0	66	8.0	66	8.0
1600	158	12.0	128	11.0	110	10.0	88	10.0	76	9.0	64	8.0	64	8.0	64	8.0
1700	161	12.0	130	11.0	111	11.0	87	10.0	75	9.0	62	9.0	62	9.0	62	9.0
1800	166	12.0	133	12.0	113	11.0	88	10.0	75	9.0	61	9.0	61	9.0	61	9.0
1900	170	13.0	136	12.0	115	11.0	89	10.0	75	10.0	61	9.0	61	9.0	61	9.0
2000	177	13.0	139	12.0	117	12.0	90	11.0	74	10.0	62	9.0	62	9.0	62	9.0
2100	184	13.0	143	13.0	121	13.0	92	10.0	74	10.0	62	9.0	62	9.0	62	9.0
2200	190	14.0	150	13.0	124	12.0	94	11.0	75	10.0	62	9.0	62	9.0	62	9.0
2300	198	14.0	154	13.0	127	13.0	96	11.0	77	10.0	63	10.0	63	10.0	63	10.0
2400	202	15.0	157	14.0	130	13.0	97	12.0	77	11.0	63	10.0	63	10.0	63	10.0
2500	208	15.0	161	14.0	133	13.0	99	12.0	78	11.0	63	10.0	63	10.0	63	10.0
2600	220	15.0	168	14.0	140	13.0	102	12.0	79	11.0	63	10.0	63	10.0	63	10.0
2700	226	16.0	172	15.0	144	14.0	106	12.0	80	11.0	64	10.0	64	10.0	64	10.0
2800	234	16.0	176	15.0	147	14.0	108	13.0	81	12.0	64	11.0	64	11.0	64	11.0
2900	240	17.0	181	15.0	151	14.0	111	13.0	82	12.0	64	11.0	64	11.0	64	11.0
3000	247	17.0	185	16.0	155	15.0	113	13.0	84	12.0	65	11.0	65	11.0	65	11.0
3100	262	17.0	194	16.0	160	15.0	116	14.0	87	12.0	66	11.0	66	11.0	66	11.0
3200	268	18.0	201	16.0	164	15.0	119	14.0	88	13.0	67	11.0	67	11.0	67	11.0

NOTE: No restrictions.

RAPID FIRE TABLE V

FUZE M728

**PROPELLANT WHITE BAG
M4A2 (CHG 3-7), M119 (CHG 8)**

WEAPON M109A1

Range to Crest	CHG 3		CHG 4		CHG 5		CHG 6		CHG 7		CHG 8	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
3300	277	18.0	205	17.0	168	16.0	121	14.0	89	13.0	67	11.0
3400	283	19.0	210	17.0	172	17.0	124	14.0	91	13.0	68	12.0
3500	291	19.0	216	17.0	177	16.0	128	15.0	93	13.0	69	12.0
3600	306	19.0	213	18.0	182	17.0	131	15.0	95	13.0	70	12.0
3700	314	20.0	229	18.0	187	17.0	135	15.0	97	14.0	72	12.0
3800	323	20.0	334	19.0	191	17.0	138	16.0	99	14.0	72	12.0
3900	331	21.0	240	19.0	198	18.0	141	16.0	101	14.0	74	13.0
4000	340	21.0	247	19.0	202	18.0	144	16.0	103	15.0	75	13.0
4500	397	23.0	281	21.0	229	20.0	166	18.0	117	16.0	81	14.0
5000	463	26.0	320	23.0	257	22.0	188	20.0	131	17.0	91	15.0
5500	546	28.0	361	25.0	290	23.0	209	21.0	148	19.0	100	16.0
6000	656	31.0	412	27.0	323	25.0	236	23.0	165	20.0	110	17.0
6500			468	30.0	362	27.0	261	25.0	185	22.0	121	19.0
7000			541	32.0	406	29.0	290	27.0	204	24.0	135	20.0
7500			626	35.0	455	32.0	322	28.0	229	25.0	147	21.0
8000					511	34.0	354	30.0	249	27.0	162	23.0
8500					583	37.0	392	32.0	277	29.0	179	25.0
9000					679	39.0	431	34.0	303	31.0	197	26.0
9500							477	37.0	333	32.0	215	28.0
10000							532	39.0	362	34.0	236	30.0
10500							597	42.0	400	36.0	256	31.0
11000							686	44.0	431	38.0	278	33.0
11500									484	41.0	305	35.0
12000									517	43.0	328	37.0
12500									600	45.0	357	39.0
13000									641	48.0	384	41.0
13500											423	43.0
14000											450	45.0
14500											497	47.0
15000											529	49.0
15500											600	52.0
16000											639	54.0

NOTE: No restrictions.

RAPID FIRE TABLE VI**FUZE M557, M564****PROPELLANT GREEN BAG M1****WEAPON M110**

Range to Crest	FUZE M557, M564					PROPELLANT GREEN BAG M1					WEAPON M110				
	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	Range Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5				
100	65	62	61	60	56	3400	362	284	222	179	130				
200	49	43	40	38	33	3500	373	293	228	185	135				
300	49	41	38	34	28	3600	408	312	240	193	140				
400	52	44	39	34	27	3700	420	323	247	199	145				
500	58	49	42	35	27	3800	432	332	253	204	149				
600	65	54	46	39	28	3900	444	341	260	210	154				
700	72	60	51	47	31	4000	458	350	267	215	158				
800	80	66	55	50	33	4500	573	416	313	241	183				
900	88	72	61	54	36	5000	763	498	361	277	209				
1000	95	79	65	58	38	5500		608	418	314	237				
1100	107	86	73	64	42	6000			491	355	266				
1200	114	92	78	67	44	6500			570	413	296				
1300	123	99	83	72	47	7000			691	471	329				
1400	132	107	89	77	51	7500				533	368				
1500	139	113	94	80	53	8000				609	407				
1600	152	124	98	85	57	8500				714	452				
1700	161	131	107	90	61	9000					504				
1800	170	140	112	95	64	9500					565				
1900	179	148	118	100	68	10000					642				
2000	189	154	123	104	71	10500					754				
2100	205	166	131	110	75										
2200	214	173	137	115	79										
2300	224	181	143	120	84										
2400	233	188	149	124	87										
2500	243	196	155	130	90										
2600	262	210	166	137	94										
2700	274	218	172	142	98										
2800	284	226	178	147	102										
2900	294	234	184	152	106										
3000	304	244	191	158	111										
3100	329	260	203	164	117										
3200	341	268	210	169	123										
3300	352	277	216	175	127										

RAPID FIRE TABLE VI

FUZE M557, M564

PROPELLANT WHITE BAG M2

WEAPON M110

Range to <u>Crest</u>	CHG <u>5</u>	CHG <u>6</u>	CHG <u>7</u>	Range to <u>Crest</u>	CHG <u>5</u>	CHG <u>6</u>	CHG <u>7</u>
100	56	55	54	3400	130	89	63
200	33	31	30	3500	135	92	65
300	28	26	23	3600	140	95	67
400	27	24	21	3700	145	99	69
500	27	23	19	3800	149	102	71
600	28	23	19	3900	154	105	73
700	31	24	19	4000	158	108	75
800	33	25	20	4500	183	128	87
900	36	27	21	5000	209	148	99
1000	38	29	22	5500	237	168	115
1100	42	32	24	6000	266	190	128
1200	44	33	25	6500	296	214	144
1300	47	35	27	7000	329	239	160
1400	51	38	28	7500	368	265	182
1500	53	39	29	8000	407	294	199
1600	57	41	31	8500	452	322	221
1700	61	44	33	9000	504	353	240
1800	64	46	34	9500	565	388	266
1900	68	49	36	10000	642	423	287
2000	71	50	37	10500		463	316
2100	75	53	38	11000		508	341
2200	79	55	40	11500		559	374
2300	84	58	42	12000		625	401
2400	87	60	44	12500		716	443
2500	90	63	46	13000			472
2600	94	65	47	13500			522
2700	98	69	49	14000			557
2800	102	72	51	14500			637
2900	106	75	53	15000			675
3000	111	78	55				
3100	117	82	58				
3200	123	85	60				
3300	127	87	62				

RAPID FIRE TABLE VI PROPELLANT GREEN BAG M1

FUZE M514

WEAPON M110

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3400	406	21.0	328	19.0	266	18.0	217	17.0	175	15.0
200	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3500	416	21.0	336	20.0	271	18.0	222	17.0	178	16.0
300	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3600	450	22.0	354	20.0	283	19.0	230	17.0	182	16.0
400	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3700	461	22.0	364	21.0	289	19.0	234	18.0	186	16.0
500	354	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3800	472	23.0	372	21.0	295	19.0	239	18.0	189	17.0
600	312	8.0	300	8.0	293	8.0	253	8.0	218	8.0	3900	485	23.0	380	22.0	300	20.0	243	18.0	193	17.0
700	284	9.0	271	9.0	262	8.0	253	8.0	218	8.0	4000	496	24.0	388	22.0	306	20.0	248	19.0	196	17.0
800	267	9.0	252	9.0	240	9.0	231	8.0	218	8.0	4500	606	27.0	449	25.0	346	22.0	276	21.0	216	19.0
900	253	10.0	236	9.0	225	9.0	214	9.0	200	8.0	5000			528	27.0	391	24.0	307	22.0	239	21.0
1000	244	10.0	227	10.0	213	9.0	201	9.0	186	8.0	5500			635	30.0	445	27.0	341	24.0	266	22.0
1100	241	10.0	220	10.0	207	10.0	193	9.0	176	9.0	6000					511	29.0	381	26.0	293	24.0
1200	238	11.0	216	10.0	202	10.0	187	10.0	168	9.0	6500					593	32.0	423	28.0	321	26.0
1300	237	11.0	213	11.0	197	10.0	181	10.0	161	9.0	7000					712	35.0	473	31.0	354	28.0
1400	238	12.0	213	11.0	195	11.0	178	10.0	157	10.0	7500							533	33.0	388	30.0
1500	238	12.0	212	12.0	193	11.0	175	10.0	152	10.0	8000							609	36.0	426	32.0
1600	245	13.0	217	12.0	194	11.0	173	11.0	150	10.0	8500							714	38.0	469	34.0
1700	248	13.0	218	12.0	194	12.0	172	11.0	148	10.0	9000									520	36.0
1800	252	13.0	222	13.0	194	12.0	172	11.0	146	11.0	9500									581	39.0
1900	257	14.0	225	13.0	196	12.0	173	12.0	146	11.0	10000									657	41.0
2000	264	14.0	228	14.0	198	13.0	174	12.0	146	11.0	10500									768	44.0
2100	276	15.0	237	14.0	202	13.0	176	12.0	146	11.0											
2200	282	15.0	241	14.0	205	13.0	178	13.0	147	12.0											
2300	289	16.0	246	15.0	208	14.0	180	13.0	148	12.0											
2400	295	16.0	250	15.0	211	14.0	182	13.0	149	12.0											
2500	303	17.0	256	16.0	215	15.0	185	14.0	150	13.0											
2600	319	17.0	267	16.0	223	15.0	189	14.0	151	13.0											
2700	329	17.0	273	16.0	227	15.0	192	14.0	153	13.0											
2800	337	18.0	279	17.0	231	16.0	195	15.0	155	14.0											
2900	345	18.0	285	17.0	235	16.0	198	15.0	157	14.0											
3000	353	19.0	293	18.0	240	16.0	201	15.0	160	14.0											
3100	377	19.0	308	18.0	251	17.0	206	16.0	165	14.0											
3200	387	20.0	314	18.0	256	17.0	210	16.0	169	15.0											
3300	397	20.0	322	19.0	261	17.0	214	16.0	172	15.0											

RAPID FIRE TABLE VI

FUZE M514					PROPELLANT WHITE BAG M2					WEAPON M110				
Range to Crest	CHG 5		CHG 6		CHG 7		Range to Crest	CHG 5		CHG 6		CHG 7		
	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	
100	218	8.0	175	8.0	147	8.0	3400	175	15.0	133	14.0	107	12.0	
200	218	8.0	175	8.0	147	8.0	3500	178	16.0	135	14.0	108	13.0	
300	218	8.0	175	8.0	147	8.0	3600	182	16.0	137	14.0	109	13.0	
400	218	8.0	175	8.0	147	8.0	3700	186	16.0	140	15.0	110	13.0	
500	218	8.0	175	8.0	147	8.0	3800	189	17.0	142	15.0	111	13.0	
600	218	8.0	175	8.0	147	8.0	3900	193	17.0	144	15.0	112	14.0	
700	218	8.0	175	8.0	147	8.0	4000	196	17.0	146	16.0	113	14.0	
800	218	8.0	175	8.0	147	8.0	4500	216	19.0	161	17.0	120	15.0	
900	200	8.0	175	8.0	147	8.0	5000	239	21.0	178	18.0	129	16.0	
1000	186	8.0	175	8.0	147	8.0	5500	266	22.0	195	20.0	142	18.0	
1100	176	9.0	164	8.0	147	8.0	6000	293	24.0	215	22.0	153	19.0	
1200	168	9.0	155	8.0	147	8.0	6500	321	26.0	237	23.0	167	20.0	
1300	161	9.0	147	9.0	139	8.0	7000	354	28.0	260	25.0	181	22.0	
1400	157	10.0	142	9.0	133	8.0	7500	388	30.0	285	27.0	200	23.0	
1500	152	10.0	136	9.0	126	9.0	8000	426	32.0	313	29.0	216	25.0	
1600	150	10.0	132	9.0	122	9.0	8500	469	34.0	339	30.0	236	27.0	
1700	148	10.0	129	10.0	118	9.0	9000	520	36.0	369	32.0	254	28.0	
1800	146	11.0	128	10.0	114	9.0	9500	581	39.0	402	34.0	281	30.0	
1900	146	11.0	127	10.0	112	9.0	10000	657	41.0	438	36.0	302	32.0	
2000	146	11.0	125	10.0	110	10.0	10500	768	44.0	475	38.0	330	34.0	
2100	146	11.0	124	11.0	107	10.0	11000			521	41.0	354	35.0	
2200	147	12.0	123	11.0	106	10.0	11500			571	43.0	387	37.0	
2300	148	12.0	123	11.0	105	10.0	12000			636	45.0	413	39.0	
2400	149	12.0	122	11.0	106	10.0	12500			723	48.0	455	41.0	
2500	150	13.0	123	12.0	106	11.0	13000					483	44.0	
2600	151	13.0	124	12.0	104	11.0	13500					533	46.0	
2700	153	13.0	124	12.0	104	11.0	14000					567	48.0	
2800	155	14.0	125	12.0	104	11.0	14500					647	50.0	
2900	157	14.0	126	13.0	104	11.0	15000					685	53.0	
3000	160	14.0	127	13.0	104	12.0								
3100	165	14.0	130	13.0	106	12.0								
3200	169	15.0	131	13.0	106	12.0								
3300	172	15.0	132	14.0	107	12.0								

NOTE: No restrictions.

RAPID FIRE TABLE VI
PROPELLANT GREEN BAG M1

FUZE M728

WEAPON M110

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	293	8.0	249	8.0	242	8.0	209	8.0	180	8.0	3400	397	21.0	319	19.0	257	18.0	208	17.0	166	15.0
200	293	8.0	249	8.0	242	8.0	209	8.0	180	8.0	3500	407	21.0	327	20.0	262	18.0	213	17.0	169	16.0
300	293	8.0	249	8.0	242	8.0	209	8.0	180	8.0	3600	441	22.0	345	20.0	274	19.0	221	17.0	173	16.0
400	293	8.0	249	8.0	242	8.0	209	8.0	180	8.0	3700	453	22.0	356	21.0	281	19.0	226	18.0	178	16.0
500	293	8.0	249	8.0	242	8.0	209	8.0	180	8.0	3800	464	23.0	364	21.0	287	19.0	231	18.0	181	17.0
600	261	8.0	249	8.0	242	8.0	209	8.0	180	8.0	3900	477	23.0	372	22.0	292	20.0	235	18.0	185	17.0
700	240	9.0	227	9.0	218	8.0	209	8.0	180	8.0	4000	488	24.0	380	22.0	298	20.0	240	19.0	188	17.0
800	229	9.0	214	9.0	202	9.0	193	8.0	180	8.0	4500	599	27.0	442	25.0	339	22.0	269	21.0	209	19.0
900	220	10.0	203	9.0	192	9.0	181	9.0	167	8.0	5000			522	27.0	385	24.0	301	22.0	233	21.0
1000	214	10.0	197	10.0	183	9.0	171	9.0	156	8.0	5500			629	30.0	439	27.0	335	24.0	260	22.0
1100	213	10.0	192	10.0	179	10.0	165	9.0	145	9.0	6000					506	29.0	376	26.0	288	24.0
1200	213	11.0	191	10.0	177	10.0	162	10.0	143	9.0	6500					588	32.0	418	28.0	316	26.0
1300	213	11.0	189	11.0	173	10.0	157	10.0	137	9.0	7000					708	35.0	469	31.0	350	28.0
1400	216	12.0	191	11.0	173	11.0	156	10.0	135	10.0	7500							529	33.0	387	30.0
1500	218	12.0	192	12.0	173	11.0	155	10.0	132	10.0	8000							605	36.0	422	32.0
1600	226	13.0	198	12.0	175	11.0	154	11.0	131	10.0	8500							711	38.0	466	34.0
1700	230	13.0	200	12.0	176	12.0	154	11.0	130	10.0	9000									517	36.0
1800	235	13.0	205	13.0	177	12.0	155	11.0	129	11.0	9500									578	39.0
1900	241	14.0	210	13.0	180	12.0	157	12.0	130	11.0	10000									654	41.0
2000	249	14.0	213	14.0	183	13.0	159	12.0	131	11.0	10500									765	44.0
2100	261	15.0	222	14.0	187	13.0	161	12.0	131	11.0											
2200	268	15.0	227	14.0	191	13.0	164	13.0	133	12.0											
2300	276	16.0	233	15.0	195	14.0	167	13.0	135	12.0											
2400	280	16.0	237	15.0	198	14.0	169	13.0	136	12.0											
2500	291	17.0	244	16.0	203	15.0	173	14.0	138	13.0											
2600	307	17.0	255	16.0	211	15.0	177	14.0	139	13.0											
2700	318	17.0	262	16.0	216	15.0	181	14.0	142	13.0											
2800	326	18.0	268	17.0	220	16.0	184	15.0	144	14.0											
2900	334	18.0	274	17.0	224	16.0	187	15.0	146	14.0											
3000	343	19.0	283	18.0	230	16.0	191	15.0	150	14.0											
3100	368	19.0	299	18.0	242	17.0	197	16.0	156	14.0											
3200	378	20.0	305	18.0	247	17.0	201	16.0	160	15.0											
3300	388	20.0	313	19.0	252	17.0	205	16.0	163	15.0											

NOTE: No restrictions.

RAPID FIRE TABLE VI

FUZE M728					PROPELLANT WHITE BAG M2					WEAPON M110				
Range to	CHG 5		CHG 6		CHG 7		Range to	CHG 5		CHG 6		CHG 7		
Crest	EL	TI	EL	TI	EL	TI	Crest	EL	TI	EL	TI	EL	TI	
100	180	8.0	145	8.0	122	8.0	3400	166	15.0	124	14.0	98	12.0	
200	180	8.0	145	8.0	122	8.0	3500	169	16.0	126	14.0	99	13.0	
300	180	8.0	145	8.0	122	8.0	3600	173	16.0	128	14.0	100	13.0	
400	180	8.0	145	8.0	122	8.0	3700	178	16.0	132	15.0	102	13.0	
500	180	8.0	145	8.0	122	8.0	3800	181	17.0	134	15.0	103	13.0	
600	180	8.0	145	8.0	122	8.0	3900	185	17.0	136	15.0	104	14.0	
700	180	8.0	145	8.0	122	8.0	4000	188	17.0	138	16.0	105	14.0	
800	180	8.0	145	8.0	122	8.0	4500	209	19.0	154	17.0	113	15.0	
900	167	8.0	145	8.0	122	8.0	5000	233	21.0	172	18.0	123	16.0	
1000	156	8.0	145	8.0	122	8.0	5500	260	22.0	189	20.0	126	18.0	
1100	148	9.0	136	8.0	122	8.0	6000	288	24.0	210	22.0	148	19.0	
1200	143	9.0	130	8.0	122	8.0	6500	316	26.0	232	23.0	162	20.0	
1300	137	9.0	123	9.0	115	8.0	7000	350	28.0	256	25.0	177	22.0	
1400	135	10.0	120	9.0	111	8.0	7500	384	30.0	281	27.0	196	23.0	
1500	132	10.0	116	9.0	106	9.0	8000	422	32.0	309	29.0	212	25.0	
1600	131	10.0	113	9.0	103	9.0	8500	466	34.0	336	30.0	233	27.0	
1700	130	10.0	111	10.0	100	9.0	9000	517	36.0	366	32.0	251	28.0	
1800	129	11.0	111	10.0	97	9.0	9500	578	39.0	399	34.0	278	30.0	
1900	130	11.0	111	10.0	96	9.0	10000	654	41.0	435	36.0	299	32.0	
2000	131	11.0	110	10.0	95	10.0	10500	765	44.0	472	38.0	327	34.0	
2100	131	11.0	109	11.0	92	10.0	11000			518	41.0	351	35.0	
2200	133	12.0	109	11.0	92	10.0	11500			569	43.0	385	37.0	
2300	135	12.0	110	11.0	92	10.0	12000			633	45.0	410	39.0	
2400	136	12.0	110	11.0	93	10.0	12500			720	48.0	452	41.0	
2500	138	13.0	111	12.0	93	11.0	13000					481	44.0	
2600	139	13.0	112	12.0	93	11.0	13500					531	46.0	
2700	142	13.0	113	12.0	93	11.0	14000					565	48.0	
2800	144	14.0	114	12.0	93	11.0	14500					644	50.0	
2900	146	14.0	115	13.0	93	11.0	15000					683	53.0	
3000	150	14.0	117	13.0	94	12.0								
3100	156	14.0	121	13.0	97	12.0								
3200	160	15.0	122	13.0	97	12.0								
3300	163	15.0	123	14.0	98	12.0								

NOTE: No restrictions.

RAPID FIRE TABLE VII

FUZE M557, M564

PROPELLANT GREEN BAG M1

WEAPON M110A1

Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	Range to Crest	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5
100	62	61	60	58	59	3400	344	271	213	170	126
200	45	42	40	37	35	3500	355	279	220	175	130
300	44	40	36	32	29	3600	373	289	231	185	139
400	48	42	35	32	28	3700	396	298	238	190	141
500	54	47	38	34	29	3800	408	306	246	195	145
600	60	53	44	37	30	3900	419	317	253	201	150
700	67	58	49	41	32	4000	433	334	260	206	154
800	74	64	53	44	34	4500	532	395	301	209	180
900	81	70	57	47	36	5000	679	470	349	270	206
1000	89	75	63	52	39	5500		566	401	281	231
1100	100	83	67	55	41	6000		709	453	344	258
1200	108	90	73	60	44	6500			540	390	288
1300	117	96	77	64	47	7000			643	439	319
1400	125	102	83	68	50	7500				497	356
1500	134	111	89	73	53	8000				566	393
1600	146	121	95	78	59	8500				659	434
1700	154	127	100	82	60	9000					482
1800	162	134	105	87	63	9500					537
1900	171	141	111	92	67	10000					605
2000	180	149	119	96	70	10500					698
2100	194	160	125	102	75						
2200	205	167	130	107	79						
2300	214	174	136	112	82						
2400	223	182	142	117	86						
2500	233	191	152	122	90						
2600	249	203	157	127	93						
2700	258	210	163	132	97						
2800	270	218	169	137	100						
2900	280	223	175	142	104						
3000	289	231	184	147	108						
3100	311	245	195	155	114						
3200	321	255	201	160	118						
3300	334	263	207	165	122						

★ RAPID FIRE TABLE VII

FUZE M557, M564
UNARMED VT

PROPELLANT WHITE BAG
M2 (CHG 5-7), M188 (CHG 8), M188A1 (CHG 8-9)

WEAPON M110A1/
M110A2

Piece- to- Crest Range	CHG 5	CHG 6	CHG 7	CHG 8	CHG 9	Piece- to- Crest Range	CHG 5	CHG 6	CHG 7	CHG 8	CHG 9
100	56	55	55	54	54	3400	116	83	61	44	38
200	34	32	32	30	30	3500	120	86	63	46	39
300	27	25	24	22	22	3600	124	89	65	47	40
400	26	23	21	19	19	3700	128	91	67	49	41
500	26	23	20	18	18	3800	132	93	69	50	42
600	28	23	20	18	17	3900	136	97	71	51	43
700	30	24	20	18	16	4000	141	102	73	53	44
800	31	25	21	18	16	4500	163	119	83	60	50
900	33	26	21	18	16	5000	189	134	95	68	56
1000	36	28	23	19	17	5500	212	154	106	76	62
1100	38	29	24	19	17	6000	238	174	121	85	69
1200	41	31	26	20	18	6500	265	197	136	94	76
1300	43	32	26	20	18	7000	296	217	150	106	84
1400	45	34	28	21	19	7500	327	244	168	116	92
1500	48	36	29	22	19	8000	360	269	186	127	100
1600	51	38	31	23	20	8500	395	297	207	139	112
1700	53	40	31	23	20	9000	437	322	225	151	122
1800	57	42	33	25	21	9500	481	358	250	167	132
1900	60	44	34	26	22	10000	535	384	271	181	142
2000	63	47	36	27	23	10500	600	427	297	196	154
2100	67	51	38	29	25	11000	683	458	320	212	165
2200	70	53	39	30	26	11500		516	352	233	180
2300	74	55	41	31	27	12000		551	376	250	193
2400	77	58	43	33	28	12500		647	411	271	208
2500	80	60	44	34	29	13000		688	440	293	224
2600	84	62	45	34	29	13500			483	317	242
2700	87	64	47	35	30	14000			515	340	258
2800	91	66	49	37	31	14500			580	368	279
2900	94	69	51	38	32	15000			616	394	297
3000	99	72	52	39	33	15500			744	427	320
3100	104	75	55	41	34	16000			789	455	342
3200	108	78	57	42	35	16500				496	368
3300	112	80	59	43	36	17000				526	392
						17500				578	422
						18000				612	448
						18500				692	486
						19000				734	514
						19500					564

C1, FM 6-50

★ **RAPID FIRE TABLE VII****FUZE ARMED M514****PROPELLANT GREEN BAG M1****WEAPON M110A1/M110A2**

Piece- to- Crest Range	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Piece- to- Crest Range	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5	
	EL	MST	EL	MST	EL	MST	EL	MST	EL	MST		EL	MST	EL	MST	EL	MST	EL	MST	EL	MST
100	349	8.0	299	8.0	290	8.0	251	8.0	218	8.0	3400	387	21.0	316	19.0	256	18.0	213	17.0	169	15.0
200	349	8.0	299	8.0	290	8.0	251	8.0	218	8.0	3500	397	21.0	323	20.0	262	18.0	217	17.0	172	16.0
300	349	8.0	299	8.0	290	8.0	251	8.0	218	8.0	3600	414	22.0	332	20.0	272	18.0	226	17.0	178	16.0
400	349	8.0	299	8.0	290	8.0	251	8.0	218	8.0	3700	436	22.0	340	20.0	278	19.0	230	18.0	181	16.0
500	349	8.0	299	8.0	290	8.0	251	8.0	218	8.0	3800	447	23.0	347	21.0	285	19.0	234	18.0	184	17.0
600	306	8.0	299	8.0	290	8.0	251	8.0	218	8.0	3900	457	23.0	357	21.0	291	20.0	239	18.0	188	17.0
700	277	9.0	268	8.0	259	8.0	251	8.0	218	8.0	4000	470	24.0	373	22.0	297	20.0	243	19.0	191	17.0
800	258	9.0	248	9.0	237	9.0	228	8.0	218	8.0	4500	564	27.0	429	24.0	333	22.0	263	21.0	212	19.0
900	245	10.0	234	9.0	221	9.0	211	9.0	200	8.0	5000	708	30.0	501	27.0	378	24.0	299	22.0	235	21.0
1000	236	10.0	223	10.0	210	9.0	199	9.0	186	8.0	5500			594	30.0	428	26.0	308	24.0	258	22.0
1100	234	10.0	217	10.0	201	10.0	189	9.0	185	9.0	6000			735	33.0	488	29.0	369	26.0	283	24.0
1200	231	11.0	213	10.0	196	10.0	183	10.0	167	9.0	6500					563	31.0	413	28.0	311	26.0
1300	231	11.0	209	11.0	191	10.0	178	10.0	161	9.0	7000					664	34.0	460	30.0	340	28.0
1400	231	12.0	208	11.0	189	11.0	174	10.0	156	9.0	7500							517	33.0	376	30.0
1500	232	12.0	209	11.0	187	11.0	171	10.0	151	10.0	8000							585	35.0	413	32.0
1600	238	12.0	213	12.0	187	11.0	170	11.0	149	10.0	8500							676	38.0	451	34.0
1700	241	13.0	214	12.0	187	12.0	169	11.0	147	10.0	9000									498	36.0
1800	244	13.0	216	13.0	187	12.0	169	11.0	145	11.0	9500									553	38.0
1900	249	14.0	219	13.0	189	12.0	170	12.0	145	11.0	0000									620	41.0
2000	254	14.0	223	13.0	193	13.0	170	12.0	144	11.0	10500									712	43.0
2100	264	15.0	230	14.0	195	13.0	172	12.0	145	11.0											
2200	271	15.0	234	14.0	197	13.0	174	13.0	146	12.0											
2300	278	15.0	238	15.0	200	14.0	176	13.0	146	12.0											
2400	284	16.0	243	15.0	203	14.0	178	13.0	147	12.0											
2500	292	16.0	250	15.0	211	14.0	181	14.0	149	13.0											
2600	306	17.0	260	16.0	214	15.0	184	14.0	150	13.0											
2700	313	17.0	265	16.0	218	15.0	187	14.0	152	13.0											
2800	323	18.0	271	17.0	222	16.0	190	15.0	153	14.0											
2900	331	18.0	276	17.0	226	16.0	193	15.0	155	14.0											
3000	338	19.0	282	17.0	233	16.0	196	15.0	157	14.0											
3100	359	19.0	295	18.0	243	17.0	203	16.0	162	14.0											
3200	367	20.0	303	18.0	247	17.0	206	16.0	164	15.0											
3300	379	20.0	310	19.0	250	17.0	210	16.0	167	15.0											

MST = Minimum Safe Time

★ RAPID FIRE TABLE VII

FUZE ARMED M514

PROPELLANT WHITE BAG
M2 (CHG 5-7), M188 (CHG 8), M188A1 (CHG 8-9)

WEAPON M110A1/M110A2

Piece- to- Crest Range	CHG 5		CHG 6		CHG 7		CHG 8		CHG 9		Piece- to- Crest Range	CHG 5		CHG 6		CHG 7		CHG 8		CHG 9		
	EL	MST	EL	MST	EL	MST	EL	MST	EL	MST		EL	MST	EL	MST	EL	MST	EL	MST	EL	MST	
100	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	3400	159	15.0	126	14.0	104	12.0	87	11.0	81	11.0	
200	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	3500	162	15.0	128	14.0	105	13.0	89	12.0	81	11.0	
300	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	3600	165	16.0	131	14.0	107	13.0	89	12.0	81	11.0	
400	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	3700	168	16.0	131	14.0	107	13.0	89	12.0	81	11.0	
500	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	3800	171	16.0	133	15.0	108	13.0	89	12.0	81	11.0	
600	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	3900	174	16.0	135	15.0	109	13.0	89	12.0	81	12.0	
700	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	4000	178	17.0	139	15.0	110	14.0	90	12.0	81	12.0	
800	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	4500	195	18.0	151	16.0	115	15.0	92	13.0	82	13.0	
900	197	8.0	175	8.0	149	8.0	127	8.0	117	8.0	5000	218	20.0	163	18.0	124	16.0	97	14.0	85	14.0	
1000	183	8.0	175	8.0	149	8.0	127	8.0	117	8.0	5500	239	22.0	181	19.0	133	17.0	103	15.0	89	14.0	
1100	172	9.0	163	8.0	149	8.0	127	8.0	117	8.0	6000	263	23.0	199	21.0	146	19.0	110	16.0	94	15.0	
1200	164	9.0	154	8.0	149	8.0	127	8.0	117	8.0	6500	288	25.0	220	23.0	159	20.0	117	18.0	99	16.0	
1300	157	9.0	146	9.0	140	8.0	127	8.0	117	8.0	7000	317	27.0	238	24.0	171	21.0	128	19.0	104	17.0	
1400	151	9.0	140	9.0	134	8.0	127	8.0	117	8.0	7500	347	29.0	264	26.0	188	23.0	136	20.0	112	18.0	
1500	146	10.0	134	9.0	127	9.0	120	8.0	117	8.0	8000	379	31.0	288	28.0	205	24.0	146	21.0	119	20.0	
1600	143	10.0	130	9.0	123	9.0	116	8.0	112	8.0	8500	412	33.0	314	30.0	224	26.0	156	23.0	129	21.0	
1700	140	10.0	127	9.0	118	9.0	110	8.0	107	8.0	9000	453	35.0	338	31.0	241	28.0	167	24.0	138	22.0	
1800	139	10.0	124	10.0	115	9.0	107	9.0	103	8.0	9500	497	37.0	374	33.0	266	30.0	183	25.0	148	23.0	
1900	138	11.0	122	10.0	112	9.0	104	9.0	100	9.0	10000	549	39.0	399	35.0	286	31.0	196	27.0	157	24.0	
2000	137	11.0	121	10.0	110	9.0	101	9.0	97	9.0	10500	614	41.0	441	37.0	311	33.0	210	28.0	168	26.0	
2100	137	11.0	121	10.0	108	10.0	99	9.0	95	9.0	11000	696	44.0	471	39.0	333	35.0	225	30.0	178	27.0	
2200	137	11.0	120	11.0	106	10.0	97	9.0	93	9.0	11500			529	41.0	365	37.0	246	32.0	193	29.0	
2300	138	12.0	119	11.0	105	10.0	95	9.0	91	9.0	12000			563	44.0	388	39.0	262	33.0	206	30.0	
2400	138	12.0	119	11.0	104	10.0	94	10.0	89	9.0	12500			659	46.0	423	41.0	283	35.0	220	32.0	
2500	139	12.0	119	11.0	103	10.0	93	10.0	88	9.0	13000			699	49.0	451	43.0	304	37.0	236	33.0	
2600	141	13.0	119	12.0	102	11.0	91	10.0	86	10.0	13500					494	45.0	328	39.0	253	35.0	
2700	142	13.0	119	12.0	102	11.0	90	10.0	85	10.0	14000					525	47.0	350	41.0	268	37.0	
2800	144	13.0	119	12.0	102	11.0	90	10.0	84	10.0	14500					590	49.0	378	43.0	289	39.0	
2900	145	13.0	120	12.0	102	11.0	89	10.0	83	10.0	15000					626	52.0	404	45.0	307	40.0	
3000	148	14.0	121	12.0	102	11.0	89	11.0	82	10.0	15500					753	54.0	436	47.0	329	42.0	
3100	152	14.0	122	13.0	103	12.0	89	11.0	82	10.0	16000					798	57.0	464	49.0	351	44.0	
3200	154	14.0	124	13.0	103	12.0	88	11.0	81	11.0	16500							505	51.0	377	46.0	
3300	157	15.0	125	13.0	104	12.0	88	11.0	81	11.0	17000							534	53.0	400	48.0	
											17500							586	56.0	430	50.0	
											18000							620	58.0	456	52.0	
											18500							700	61.0	494	54.0	
											19000							742	64.0	522	57.0	
											19500								571	59.0		

C1, FM 6-50

F-41

MST = Minimum Safe Time

★ **RAPID FIRE TABLE VII****FUZE M728****PROPELLANT GREEN BAG M1****WEAPON M110A1**

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3400	363	21.0	292	19.0	232	18.0	189	17.0	145	15.0
200	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3500	374	21.0	300	20.0	239	18.0	194	17.0	149	16.0
300	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3600	391	22.0	309	20.0	249	18.0	203	17.0	155	16.0
400	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3700	416	22.0	318	20.0	256	19.0	208	18.0	159	16.0
500	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3800	425	23.0	325	21.0	263	19.0	212	18.0	162	17.0
600	170	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3900	436	23.0	336	21.0	270	20.0	218	18.0	167	17.0
700	161	9.0	152	8.0	143	8.0	135	8.0	117	8.0	4000	449	24.0	352	22.0	276	20.0	222	19.0	170	17.0
800	157	9.0	147	9.0	136	9.0	127	8.0	117	8.0	4500	546	27.0	411	24.0	315	22.0	245	21.0	194	19.0
900	155	10.0	144	9.0	131	9.0	121	9.0	110	8.0	5000	692	30.0	485	27.0	362	24.0	283	22.0	219	21.0
1000	155	10.0	142	10.0	129	9.0	118	9.0	105	8.0	5500			579	30.0	413	26.0	293	24.0	243	22.0
1100	160	10.0	143	10.0	127	10.0	115	9.0	101	9.0	6000			721	33.0	474	29.0	355	26.0	269	24.0
1200	163	11.0	145	10.0	128	10.0	115	10.0	99	9.0	6500					550	31.0	400	28.0	298	26.0
1300	168	11.0	147	11.0	128	10.0	115	10.0	98	9.0	7000					653	34.0	449	30.0	329	28.0
1400	172	12.0	149	11.0	130	11.0	115	10.0	97	9.0	7500							506	33.0	365	30.0
1500	178	12.0	155	11.0	133	11.0	117	10.0	97	10.0	8000							574	35.0	401	32.0
1600	187	12.0	162	12.0	136	11.0	119	11.0	98	10.0	8500							667	38.0	442	34.0
1700	193	13.0	166	12.0	139	12.0	121	11.0	99	10.0	9000									489	36.0
1800	199	13.0	171	13.0	142	12.0	124	11.0	100	11.0	9500									544	38.0
1900	206	14.0	176	13.0	146	12.0	127	12.0	102	11.0	10000									612	41.0
2000	213	14.0	182	13.0	152	13.0	129	12.0	105	11.0	10500									704	43.0
2100	225	15.0	191	14.0	156	13.0	133	12.0	106	11.0											
2200	235	15.0	197	14.0	160	13.0	137	13.0	109	12.0											
2300	243	15.0	203	15.0	165	14.0	141	13.0	111	12.0											
2400	250	16.0	209	15.0	169	14.0	144	13.0	113	12.0											
2500	259	16.0	217	15.0	178	15.0	148	14.0	116	13.0											
2600	275	17.0	229	16.0	183	15.0	153	14.0	119	13.0											
2700	283	17.0	235	16.0	188	16.0	157	14.0	122	13.0											
2800	294	18.0	242	17.0	193	16.0	161	15.0	124	14.0											
2900	303	18.0	248	17.0	198	16.0	165	15.0	127	14.0											
3000	311	19.0	255	17.0	206	16.0	169	15.0	130	14.0											
3100	333	19.0	269	18.0	217	17.0	177	16.0	136	14.0											
3200	342	20.0	278	18.0	222	17.0	181	16.0	139	15.0											
3300	354	20.0	285	19.0	227	17.0	185	16.0	142	15.0											

NOTE: No restrictions.

★ RAPID FIRE TABLE VII

FUZE ARMED M728

PROPELLANT WHITE BAG
M2 (CHG 5-7), M188 (CHG 8), M188A1 (CHG 8-9)

WEAPON M110A1/M110A2

Piece- to- Crest Range	CHG 5	CHG 6	CHG 7	CHG 8	CHG 9	Piece- to- Crest Range	CHG 5	CHG 6	CHG 7	CHG 8	CHG 9
EL MST	EL MST	EL MST	EL MST	EL MST	EL MST	EL MST	EL MST	EL MST	EL MST	EL MST	EL MST
100	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	3400	135 15.0	102 14.0	80 12.0	63 11.0	57 11.0
200	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	3500	139 16.0	105 14.0	82 13.0	65 12.0	58 11.0
300	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	3600	142 16.0	107 14.0	83 13.0	65 12.0	58 11.0
400	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	3700	146 16.0	109 15.0	85 13.0	67 12.0	59 11.0
500	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	3800	149 17.0	111 15.0	86 13.0	67 12.0	59 11.0
600	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	3900	153 17.0	114 15.0	88 14.0	68 12.0	60 12.0
700	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	4000	157 17.0	118 16.0	89 14.0	69 12.0	60 12.0
800	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	4500	176 19.0	133 17.0	97 15.0	74 13.0	64 13.0
900	107 8.0	94 8.0	81 8.0	68 8.0	63 8.0	5000	202 21.0	147 18.0	108 16.0	81 14.0	69 14.0
1000	102 8.0	94 8.0	81 8.0	68 8.0	63 8.0	5500	224 22.0	166 20.0	118 18.0	88 15.0	74 14.0
1100	98 9.0	89 8.0	81 8.0	68 8.0	63 8.0	6000	249 24.0	185 22.0	132 19.0	96 16.0	80 15.0
1200	96 9.0	86 8.0	81 8.0	68 8.0	63 8.0	6500	275 26.0	207 23.0	146 20.0	104 18.0	86 16.0
1300	94 9.0	83 9.0	77 8.0	68 8.0	63 8.0	7000	306 28.0	227 25.0	160 22.0	115 19.0	94 17.0
1400	92 10.0	81 9.0	75 8.0	68 8.0	63 8.0	7500	336 30.0	253 27.0	177 23.0	125 20.0	101 18.0
1500	92 10.0	80 9.0	73 9.0	66 8.0	63 8.0	8000	368 32.0	277 29.0	194 25.0	135 21.0	108 20.0
1600	92 10.0	79 9.0	73 9.0	64 8.0	61 8.0	8500	403 34.0	305 30.0	215 27.0	147 23.0	120 21.0
1700	92 10.0	79 10.0	70 9.0	62 8.0	59 8.0	9000	444 36.0	328 32.0	232 28.0	158 24.0	129 22.0
1800	94 11.0	79 10.0	70 9.0	62 9.0	58 8.0	9500	488 39.0	365 34.0	257 30.0	164 25.0	139 23.0
1900	95 11.0	79 10.0	69 9.0	61 9.0	57 9.0	10000	541 41.0	391 36.0	278 32.0	188 27.0	149 24.0
2000	96 11.0	80 10.0	69 10.0	60 9.0	56 9.0	10500	606 44.0	433 38.0	303 34.0	202 28.0	160 26.0
2100	98 11.0	82 11.0	69 10.0	60 9.0	56 9.0	11000		464 41.0	326 35.0	218 30.0	171 27.0
2200	100 12.0	83 11.0	69 10.0	60 9.0	56 9.0	11500		522 43.0	358 37.0	239 32.0	186 29.0
2300	103 12.0	84 11.0	70 10.0	60 9.0	56 9.0	12000		556 45.0	381 39.0	256 33.0	199 30.0
2400	104 12.0	85 11.0	70 10.0	60 10.0	55 9.0	12500		652 48.0	416 41.0	277 35.0	213 32.0
2500	106 13.0	86 12.0	70 11.0	60 10.0	55 9.0	13000			445 44.0	298 37.0	230 33.0
2600	110 13.0	88 12.0	71 11.0	60 10.0	55 10.0	13500			488 46.0	322 39.0	247 35.0
2700	112 13.0	89 12.0	72 11.0	60 10.0	55 10.0	14000			520 48.0	345 41.0	263 37.0
2800	115 14.0	90 12.0	73 11.0	61 10.0	55 10.0	14500			584 50.0	372 43.0	283 39.0
2900	117 14.0	92 13.0	74 11.0	61 10.0	55 10.0	15000			620 53.0	398 45.0	301 40.0
3000	121 14.0	94 13.0	74 12.0	61 11.0	55 10.0	15500				431 47.0	324 42.0
3100	126 14.0	97 13.0	77 12.0	63 11.0	56 10.0	16000				459 49.0	346 44.0
3200	129 15.0	99 13.0	78 12.0	63 11.0	56 11.0	16500				500 51.0	372 46.0
3300	132 15.0	100 14.0	79 12.0	63 11.0	56 11.0	17000				530 53.0	396 48.0
						17500				582 56.0	426 50.0
						18000				615 58.0	451 52.0
						18500				695 61.0	489 54.0
						19000				737 64.0	517 57.0
						19500					567 59.0

★ RAPID FIRE TABLE VIII

FUZE M572

PROPELLANT M124 (Green Bag)
M86 Series (White Bag)

WEAPON M107

Range to Crest	CHG 1	CHG 2	CHG 3	Range to Crest	CHG 1	CHG 2	CHG 3	Range to Crest	CHG 2	CHG 3
100	12	10	7	3300	82	42	23	16500	421	184
200	10	7	4	3400	84	43	24	17000	446	194
300	12	8	4	3500	87	44	24	17500	484	204
400	14	9	5	3600	90	46	25	18000	512	216
500	16	10	5	3700	92	47	26	18500	559	225
600	17	10	5	3800	95	48	27	19000	590	237
700	19	11	6	3900	98	50	27	19500	659	246
800	21	12	6	4000	101	51	28	20000	696	261
900	23	13	7	4500	117	58	30	20500		272
1000	25	14	8	5000	132	67	39	21000		285
1100	28	15	8	5500	152	76	43	21500		298
1200	31	16	9	6000	169	84	48	22000		314
1300	33	17	9	6500	191	92	52	22500		327
1400	35	18	10	7000	210	100	57	23000		343
1500	37	19	11	7500	234	110	61	23500		359
1600	39	20	11	8000	257	120	66	24000		376
1700	41	22	12	8500	285	132	72	24500		392
1800	44	23	13	9000	308	142	77	25000		411
1900	46	24	13	9500	340	154	81	25500		430
2000	48	25	14	10000	368	166	87	26000		448
2100	51	27	15	10500	405	181	92	26500		471
2200	54	28	15	11000	433	193	99	27000		491
2300	56	29	16	11500	484	208	105	27500		518
2400	58	31	17	12000	516	224	112	28000		542
2500	61	32	17	12500	588	241	118	28500		574
2600	63	33	18	13000	626	259	125	29000		599
2700	66	34	19	13500	771	277	134	29500		647
2800	68	35	19	14000		297	142	30000		675
2900	71	37	20	14500		321	150	30500		757
3000	73	38	21	15000		340	158	31000		791
3100	77	39	22	15500		367	166			
3200	79	40	22	16000		390	176			

RAPID FIRE TABLE VIII

FUZE M514

PROPELLANT M124 (Green Bag)
M86 Series (White Bag)

WEAPON M107

Range to Crest	CHG 1		CHG 2		CHG 3		Range to Crest	CHG 1		CHG 2		CHG 3		Range to Crest	CHG 2		CHG 3	
	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI		EL	TI	EL	TI
100	177	8.0	170	8.0	165	8.0	3300	128	13.0	88	11.0	69	10.0	16500	430	47.0	193	35.0
200	177	8.0	170	8.0	165	8.0	3400	128	13.0	87	11.0	68	10.0	17000	454	49.0	202	36.0
300	177	8.0	170	8.0	165	8.0	3500	130	14.0	87	11.0	67	10.0	17500	492	51.0	212	38.0
400	177	8.0	170	8.0	165	8.0	3600	132	14.0	88	12.0	67	10.0	18000	520	54.0	224	39.0
500	177	8.0	170	8.0	165	8.0	3700	133	14.0	88	12.0	67	10.0	18500	567	56.0	233	40.0
600	177	8.0	170	8.0	165	8.0	3800	135	14.0	88	12.0	67	11.0	19000	598	58.0	245	42.0
700	177	8.0	170	8.0	165	8.0	3900	137	15.0	89	12.0	66	11.0	19500	666	61.0	253	44.0
800	177	8.0	170	8.0	165	8.0	4000	139	15.0	89	12.0	66	11.0	20000	703	64.0	268	45.0
900	177	8.0	170	8.0	165	8.0	4500	150	16.0	91	13.0	63	11.0	20500			279	47.0
1000	177	8.0	170	8.0	165	8.0	5000	162	18.0	97	14.0	69	12.0	21000			292	48.0
1100	166	8.0	170	8.0	165	8.0	5500	179	19.0	103	15.0	70	13.0	21500			305	50.0
1200	158	8.0	170	8.0	165	8.0	6000	194	21.0	109	16.0	73	14.0	22000			320	52.0
1300	150	9.0	170	8.0	165	8.0	6500	214	22.0	115	17.0	75	14.0	22500			333	54.0
1400	144	9.0	170	8.0	165	8.0	7000	231	24.0	121	18.0	78	15.0	23000			349	55.0
1500	138	9.0	170	8.0	165	8.0	7500	254	25.0	130	19.0	81	16.0	23500			365	57.0
1600	134	9.0	115	8.0	165	8.0	8000	276	27.0	139	20.0	85	17.0	24000			382	59.0
1700	130	9.0	111	8.0	165	8.0	8500	302	29.0	149	22.0	89	18.0	24500			398	61.0
1800	128	10.0	107	9.0	165	8.0	9000	324	31.0	159	23.0	93	18.0	25000			417	61.0
1900	126	10.0	104	9.0	93	8.0	9500	356	33.0	170	24.0	97	19.0	25500			435	65.0
2000	124	10.0	101	9.0	90	8.0	10000	383	34.0	181	25.0	102	20.0	26000			453	67.0
2100	123	10.0	99	9.0	87	8.0	10500	419	36.0	195	27.0	106	21.0	26500			476	69.0
2200	123	11.0	97	9.0	84	8.0	11000	446	38.0	206	28.0	112	22.0	27000			496	71.0
2300	122	11.0	95	9.0	82	9.0	11500	497	40.0	221	30.0	118	23.0	27500			523	74.0
2400	121	11.0	94	10.0	80	9.0	12000	528	43.0	236	31.0	124	24.0	28000			547	76.0
2500	122	11.0	93	10.0	78	9.0	12500	600	45.0	253	33.0	130	25.0	28500			579	78.0
2600	122	12.0	91	10.0	76	9.0	13000	637	47.0	270	34.0	136	26.0	29000			604	81.0
2700	122	12.0	90	10.0	75	9.0	13500			288	36.0	145	27.0	29500			652	83.0
2800	122	12.0	89	10.0	73	9.0	14000			307	38.0	152	28.0	30000			680	86.0
2900	123	12.0	89	10.0	72	9.0	14500			331	40.0	160	30.0	30500			761	89.0
3000	123	12.0	88	11.0	71	9.0	15000			350	41.0	168	31.0	31000			795	92.0
3100	126	13.0	88	11.0	71	10.0	15500			376	43.0	175	32.0					
3200	126	13.0	87	11.0	69	10.0	16000			399	45.0	185	33.0					

NOTE: For specific exceptions to restrictions indicated, see TM 9-2300-216-10 or TM 43-0001-28.

RAPID FIRE TABLE VIII

FUZE M728

PROPELLANT M124 (Green Bag)
M86 Series (White Bag)

WEAPON M107

Range to Crest	CHG 1		CHG 2		CHG 3		Range to Crest	CHG 1		CHG 2		CHG 3		Range to Crest	CHG 2		CHG 3	
	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI		EL	TI	EL	TI
100	147	8.0	148	8.0	148	8.0	3300	119	13.0	78	11.0	60	10.0	16500	428	47.0	191	35.0
200	147	8.0	148	8.0	148	8.0	3400	119	13.0	78	10.0	58	10.0	17000	453	49.0	201	35.0
300	147	8.0	148	8.0	148	8.0	3500	121	14.0	78	11.0	58	10.0	17500	491	51.0	211	38.0
400	147	8.0	148	8.0	148	8.0	3600	123	14.0	79	12.0	58	10.0	18000	518	54.0	222	39.0
500	147	8.0	148	8.0	148	8.0	3700	125	14.0	80	12.0	59	10.0	18500	565	56.0	231	40.0
600	147	8.0	148	8.0	148	8.0	3800	127	14.0	80	12.0	59	11.0	19000	596	58.0	243	42.0
700	147	8.0	148	8.0	148	8.0	3900	129	15.0	81	12.0	58	11.0	19500	664	61.0	251	44.0
800	147	8.0	148	8.0	148	8.0	4000	131	15.0	81	12.0	58	11.0	20000	701	64.0	266	45.0
900	147	8.0	148	8.0	148	8.0	4500	143	16.0	84	13.0	56	11.0	20500			277	47.0
1000	147	8.0	148	8.0	148	8.0	5000	156	18.0	91	14.0	63	12.0	21000			290	48.0
1100	138	8.0	148	8.0	148	8.0	5500	173	19.0	97	15.0	64	13.0	22000			304	50.0
1200	133	8.0	148	8.0	148	8.0	6000	189	21.0	104	16.0	68	14.0	22000			319	52.0
1300	126	9.0	148	8.0	148	8.0	6500	209	22.0	110	17.0	70	14.0	22500			332	54.0
1400	122	9.0	148	8.0	148	8.0	7000	227	24.0	117	18.0	74	15.0	23000			348	55.0
1500	120	9.0	100	8.0	148	8.0	7500	250	25.0	126	19.0	77	16.0	23500			364	57.0
1600	115	9.0	96	8.0	148	8.0	8000	272	27.0	135	20.0	81	17.0	24000			380	59.0
1700	112	9.0	93	8.0	148	8.0	8500	299	29.0	145	22.0	86	18.0	24500			396	61.0
1800	111	10.0	90	9.0	148	8.0	9000	321	31.0	156	23.0	90	18.0	25000			415	63.0
1900	110	10.0	88	9.0	77	8.0	9500	353	33.0	167	24.0	94	19.0	25500			434	65.0
2000	109	10.0	86	9.0	75	8.0	10000	380	34.0	178	25.0	99	20.0	26000			452	67.0
2100	108	10.0	84	9.0	72	8.0	10500	416	36.0	192	27.0	103	21.0	26500			475	69.0
2200	109	11.0	83	9.0	70	8.0	11000	443	38.0	203	28.0	109	22.0	27000			495	71.0
2300	109	11.0	82	9.0	69	9.0	11500	495	40.0	219	30.0	116	23.0	27500			522	74.0
2400	108	11.0	81	10.0	67	9.0	12000	525	43.0	233	31.0	121	24.0	28000			546	76.0
2500	110	11.0	81	10.0	66	9.0	12500	597	45.0	250	33.0	127	25.0	28500			578	78.0
2600	110	12.0	79	10.0	64	9.0	13000	635	47.0	268	34.0	134	26.0	29000			603	81.0
2700	111	12.0	79	10.0	64	9.0	13500			286	36.0	143	27.0	29500			651	83.0
2800	111	12.0	78	10.0	62	9.0	14000			305	38.0	150	28.0	30000			679	86.0
2900	112	12.0	78	10.0	61	9.0	14500			228	40.0	157	30.0	30500			760	89.0
3000	113	12.0	78	11.0	61	9.0	15000			343	41.0	166	31.0	31000			794	92.0
3100	117	13.0	78	11.0	62	10.0	15500			374	43.0	173	32.0					
3200	117	13.0	78	11.0	60	10.0	16000			399	45.0	183	33.0					

NOTE: No restrictions.

APPENDIX G

COMMON MISTAKES AND MALPRACTICES

G-1. General

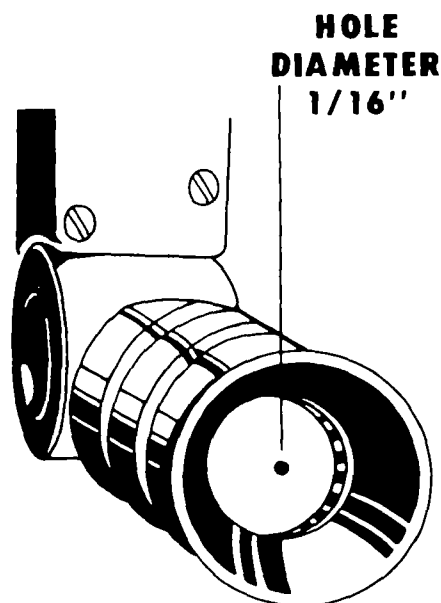
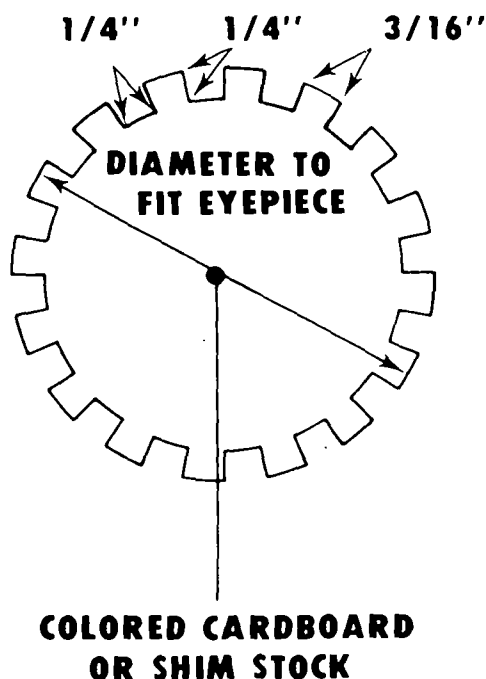
Inaccuracies in field artillery fire cause wasted rounds and a decrease in the effectiveness of fire support. A large percentage of these inaccuracies can be attributed to careless and/or improper procedures at the gun. The key to minimizing human error and careless gunnery procedures is proper training. The following problem areas will serve the commander as a starting point for evaluating the training level of his unit. The problem areas listed are only guides, and he must use them together with close, aggressive supervision and an ongoing training program.

G-2. Common Mistakes

Although these mistakes may seem obvious,

they occur all too often.

- a. Firing a wrong charge.
- b. Laying on the wrong aiming posts (especially at night).
- c. Failure to zero the gunner's aid.
- d. Transposition of numbers.
- e. Failure to level pitch and cross-level bubbles.
- f. Failure to compensate for backlash by moving the panoramic telescope from left to right when approaching an aiming point.
- g. Errors in boresighting due to parallax. The gunner can eliminate parallax by using parallax shields and breech boresights. Here's an example of a parallax shield—



G-3. Malpractices

Malpractices include blatant violations of standard doctrine/procedures set forth in FMs, TMs, and other publications. Some of the more common are:

a. Exceeding the maximum and/or sustained rates of fire.

b. Improper ramming, which may result in the projectile falling back on the powder when the tube is elevated (separate-loading ammunition).

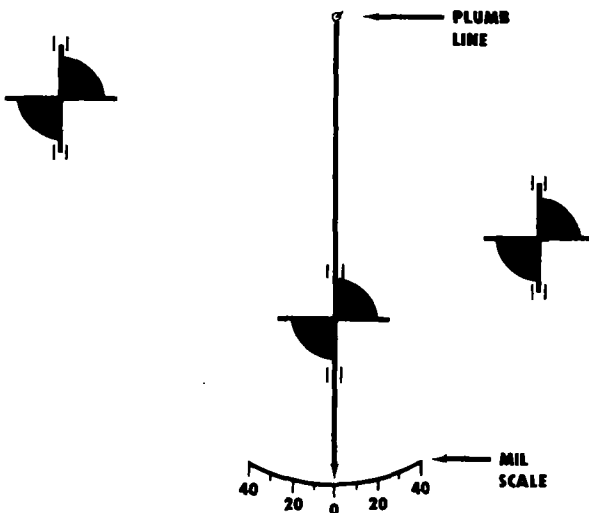
c. Improper testing of the gunner's quadrant.

d. Incomplete and/or improper fire control alinement tests. These tests **MUST** be conducted by the book!

e. Leaving projectiles and/or powder increments exposed to direct sunlight for prolonged periods of time.

f. Failure to clean projectiles before loading.

g. Boresighting by the testing target method in the field without compensating for the cant of the weapon trunnions. The testing target should be scribed like this—

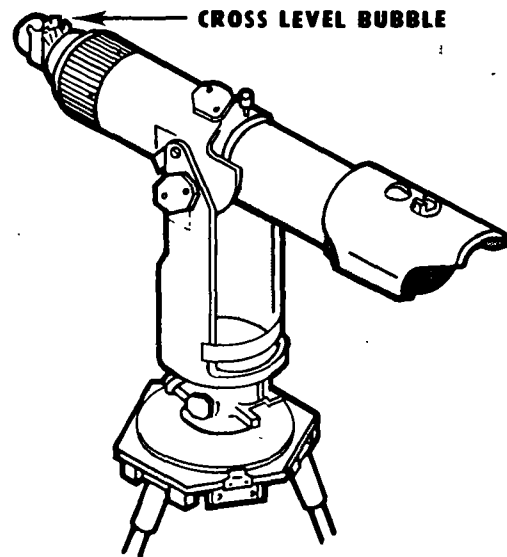


h. Attempting to boresight a weapon that is losing hydraulic pressure. The tube does not remain at a fixed elevation but depresses gradually, which causes errors in boresighting.

i. Lifting a time-fuzed round with a hand around the fuze. When this is done, it is very easy to change the fuze setting.

j. Failure to use a fuze wrench when tightening fuzes.

k. Failure to cross-level the collimator. The cross-level bubble **MUST** be centered before the collimator can be used as an aiming point.



l. Firing a round through an oily tube. Tubes must be **DRY** prior to firing.

m. Exceeding the maximum practical quadrant elevation. The tabular firing tables sometimes list high angles of elevation that *should not* be fired by certain weapons. The affected weapons are indicated below. Firing a weapon above these maximum practical QE's may result in rounds that impact base first or on their sides, producing duds and unpredictable locations of impact.

G-4. Use of the Aiming Circle

Generally, the person setting up the aiming circle is in a hurry—the battery is pulling in and he wants to get the guns laid as quickly as possible. This situation leads to careless procedures. Here are some of the more common ones:

a. Failure to tighten the instrument-fixing screw securely. The head of the aiming circle

will turn on the tripod, which causes an error in readings.

b. Not clearing the area of magnetic attractions, especially weapons, steel helmets, and eyeglasses, when the magnetic needle is used.

c. Failing to first roughly orient the 0-3200 line when measuring an azimuth or an orienting angle. This leads to 3,200-mil errors.

d. Inadvertently reading the red numbers rather than the black numbers on the azimuth scale.

e. Failure to set up the tripod so that one leg points in the approximate direction of sighting. This puts one tripod leg in the instrument operator's way as he moves around and increases the likelihood he will knock the aiming circle off level (or worse).

f. Inadvertently moving the LOWER motion when movement of the UPPER motion is desired.

g. Making a 100-mil error in reading or setting. This is easy to do if you are not careful to read the numbers on the azimuth scale in a CLOCKWISE direction.

Howitzer	Charge	Maximum practical QE
M102	1	1270
	2	1280
	3	1290
	4	1305
	5	1315
	6	1310
	7	1295
M109	1	1255
	2	1270
	3	1285
	4	1295
	5	1295
	6	1285
	7	1270
Howitzer	Charge	Maximum practical QE
M109A1	1	1240
	2	1260
	3	1280
	4	1290
	5	1280
	6	1270
	7	1260
	8	1240



★APPENDIX H

INTERNATIONAL STANDARDIZATION AGREEMENTS

H-1. General

Standardization agreements (STANAGs and QSTAGs) are international agreements designed to facilitate allied operations. Upon ratification by the United States, these standardization agreements are binding upon the United States Forces (entirely or with exceptions as noted).

a. STANAG

A STANAG is the record of an agreement among several or all of the member nations of NATO to adopt like or similar military equipment, ammunition, supplies, and stores and operational, logistic, and administrative procedures. A list of STANAGs in use or under development is published in NATO Allied Administrative Publication (AAP) 4.

b. QSTAG

A QSTAG is an agreement between two or more ABCA countries (United States, United Kingdom, Canada, and Australia) similar in scope to a STANAG. A list of QSTAGs is published in the Quadripartite Standardization Agreement List (QSAL).

c. The following STANAGs/QSTAGs are included in this appendix:

- (1) STANAG 2008/QSTAG 503—*Bombing, Shelling, Mortaring and Location Reports.*
- (2) STANAG 2047/QSTAG 183—*Emergency Alarms of Hazard or Attack (NBC and Air Attack Only).*
- (3) STANAG 2113/QSTAG 534—*Destruction of Military Technical Equipment.*
- (4) STANAG 2154/QSTAG 539—*Regulations for Military Motor Vehicle Movement by Road.*

H-2. STANAG 2008: Bombing, Shelling, Mortaring and Location Reports. (Edition No. 4) NAVY/ARMY/AIR

ANNEX: A. Format for BOMREP, SHELREP, MORTREP or LOCATION REPORT.

Related Documents:	STANAG 2020—	<i>Operational Situation Reports.</i>
	STANAG 2103—	<i>Reporting Nuclear Detonations, Radioactive Fallout, and Biological and Chemical Attacks and Predicting Associated Hazards.</i>

AIM

1. The aim of this agreement is to standardize, for the use of the NATO Forces, the method of rendering reports on enemy bombing, shelling, mortaring and locations.

AGREEMENT

2. It is agreed that the NATO Forces are to use the format shown at Annex A when rendering enemy bombing, shelling, mortaring and location reports. (Additional reporting required when NBC weapons are involved is covered in STANAG 2103.) Nations are free to use their own national forms once the basic information has been received by means of the code letters.

3. It is further agreed that the format is to be completed as detailed in the following paragraphs of this agreement.

CLASSIFICATION OF REPORTS

4. Completed reports are to be classified in accordance with current security regulations.

METHOD OF RENDERING AND TRANSMISSION

5. Reports are rendered as normal messages and are to be transmitted by the fastest means available.

CODE WORDS

6. Each transmission is to be preceded by one of the following code words:

- a. SHELREP (in the case of enemy artillery fire).
- b. MORTREP (in the case of enemy mortar or rocket fire).
- c. BOMREP (in the case of enemy air attack).
- d. LOCATION REPORT (in the case of location of enemy target). (1)

SECURITY OF MESSAGES

7. The message is always transmitted in clear except as follows:

- a. Unit of Origin—Paragraph A of Annex A. The current call sign, address group or equivalent is to be used.
- b. Position of Observer—Paragraphs B and F.1.b. of Annex A. This is to be encoded if it discloses the location of a headquarters or an important observer post.
- c. When the originator considers that the conditions prevailing warrant a higher classification (e.g., paragraph K, if required).

PARAGRAPHS

8. Each paragraph of the report has a letter and a heading. The headings may be included for easy reference to facilitate completion, but only the letters are to be transmitted if the report is sent by radio or telephone.

9. Paragraphs which cannot be completed or are not applicable are omitted from the report.

IMPLEMENTATION OF THE AGREEMENT

10. This STANAG will be considered to have been implemented when the necessary orders/instructions to adopt the method described in this Agreement have been issued to the forces concerned.

Note (1). To avoid confusion with LOGREP (LOGISTIC REPORT) LOCATION REPORT is written and spoken in full.

ANNEX A TO STANAG 2008 (Edition No. 4)
FORMAT FOR BOMBING, SHELLING, MORTARING AND LOCATION REPORTS
(SECURITY CLASSIFICATION)
BOMREP, SHELREP, MORTREP OR LOCATION REPORT
(indicate which)

- A. UNIT OF ORIGIN. Use current call sign, address or group or code name.
- B. POSITION OF OBSERVER. Grid reference preferred—encode if this discloses the location of a headquarters or important observation posts.
- C. DIRECTION (FLASH, SOUND OR GROOVE) AND ANGLE OF FALL/DESCENT. (Omit for aircraft.) Grid bearing of flash, sound or groove of shell (state which) in mils, unless otherwise specified. The angle of fall or descent may be determined by placing a stick/rod in the fuze tunnel and measuring in mils, unless otherwise specified, the angle formed by the stick/rod in relation to the horizontal plane.
- D. TIME FROM.
- E. TIME TO.
- F. AREA BOMBED, SHELLED OR MORTARED.
1. Location to be sent as:
 - a. grid reference (clear reference is to be used)OR
 - b. grid bearing to impact points in mils, unless otherwise specified, and distance in meters from observer. This information must be encoded if paragraph B is encoded. (When this method is used, maximum accuracy possible is essential.)
 2. Dimensions of the area bombed, shelled or mortared to be given by:
 - a. the radius (in metres)OR
 - b. the length and the width (in metres).
- G. NUMBER AND NATURE OF GUNS, MORTARS, ROCKET LAUNCHERS, AIRCRAFT OR OTHER METHODS OF DELIVERY.
- H. NATURE OF FIRE. Adjustment, fire for effect, harassing, etc. (May be omitted for aircraft.)
- I. NUMBER, TYPE AND CALIBER (State whether measured or assumed.) OF SHELLS, ROCKETS (OR MISSILES), BOMBS, ETC.
- J. TIME OF FLASH TO BANG. (Omit for aircraft.)
- K. DAMAGE. (Encode if required.)
- L. REMARKS.
- M. SERIAL NUMBER. (Each location which is produced by a locating unit is given a serial number.)
- N. TARGET NUMBER. (If the weapon/activity has previously been given a target number, it will be entered in this column by the locating units.)
- P. POSITION OF TARGET (the grid reference and grid bearing and distance of the located weapon/activity).
- Q. ACCURACY (the accuracy to which the weapon/activity located. CEP in metres and the means of location if possible).

R. TIME OF LOCATION (the actual time the location was made).

S. TARGET DESCRIPTION (dimensions if possible):

1. radius of target in metres

OR

2. target length and width in metres.

T. TIME FIRED (against hostile target).

U. FIRED BY.

V. NUMBER OF ROUNDS - TYPE OF FUZE AND PROJECTILES.

H-3. STANAG 2047 (2nd Draft): Emergency Alarms of Hazard or Attack (NBC and Air Attack Only) (Edition No. 5) NAVY/ARMY/AIR

ANNEX: A. Alarm Signals

Related documents:	STANAG 2002 (NBC)—	<i>Marking of Contaminated or Dangerous Land Areas, Complete Equipments, Supplies and Stores.</i>
	STANAG 2103 (NBC)—	<i>Reporting Nuclear Detonation, Radioactive Fallout and Biological and Chemical Attacks and Predicting Associated Hazards.</i>
	STANAG 2104 (NBC)—	<i>Friendly Nuclear Strike Warning to Armed Forces Operating on Land.</i>
	STANAG 2889 (ENGR)—	<i>Marking of Hazardous Areas and Routes Through Them.</i>

AIM

1. The aim of this agreement is to provide a standard method of giving emergency alarms within the NATO Forces operating on land, of:

- a. Nuclear, biological or chemical (NBC) hazards and strikes.
- b. Air attack.

AGREEMENT

2. Participating nations agree that NATO Forces, when operating on land, will use the alarm signals detailed herein to give emergency alarms of hazard or attack. Audible and visual alarm signals must be given by means which cannot easily be confused with other sounds or sights encountered in combat. The alarm signals will be given in all cases as soon as an attack or the presence of a hazard is detected. The alarm signals will be repeated throughout the unit area by all who hear or see the original alarm signal since most available alarm signals are generally limited in range. Additionally, audible and visual alarm signals should normally be supplemented by the simultaneous use of radio, telephone and public address systems.

GENERAL

3. It is unlikely that personnel can understand and react quickly and correctly to more than two alarm signals. The two hazards which require fast and correct reaction are NBC (nuclear, biological and chemical) contamination and, secondly, imminent air attack. Therefore, alarm signals for these two hazards are mandatory. (See Note (1).)

4. The spoken word (vocal alarm signals) remains the most effective means of informing troops in an emergency.

5. The situation may arise when it is necessary to take account of the presence of more than one of the specific hazards or attacks. Action to be taken will be:

For the simultaneous or near simultaneous occurrence of more than one hazard or attack, the alarm signals will first be given for the hazard or attack requiring the fastest preventive action, followed immediately by the signal for the other hazard or attack.

6. Visual alarm signals are included to supplement the audible alarm signals under conditions when audible signals may be lost due to other noises or to replace audible signals when the tactical situation does not permit the use of sound:

a. Reliance should not be placed on visual alarm signals during the hours of darkness or in conditions of poor light.

b. Visual alarm signals (color) would be more appropriate to fixed installations (as a supplementary method of warning) than to mobile land forces as the existing profusion of colored tactical signs, pennants, etc., already employed by mobile land forces may lead to misinterpretation.

c. Visual signals should be used to warn those personnel arriving at a particular location of an imminent hazard.

d. Apart from the audio-visual signals detailed at para 2 of Annex A, normal signal flares are excluded from use as a colour alarm signal for NBC and Air Attack.

7. The actual form of a visual alarm signal (For colours, see Annex A.) and the method of its display is left to the discretion of the local commander. However, visual alarm signals should clearly differentiate between the major types of threat and should be as simple as possible in order that all personnel may readily understand the alarm signals.

ALARM SIGNALS

8. Alarm signals for use by NATO Forces operating on land are in Annex A. There are some differences between the alarm signals prescribed herein and some national civil defense alarm signals. These differences are considered minor and will exist until the nations standardize on civil defense alarm signals.

9. Until such time as agreement is reached on civil alarm signals, NATO Forces will ascertain what audible alarm signals are prohibited by the nation in whose territory they are operating before employing audible alarm signals prescribed in this agreement.

PRACTICE ALARM SIGNALS

10. In some cases nations or local regulations preclude sounding alarm signals during exercises. In such cases local commanders should negotiate with local authorities to obtain authorization to sound alarm signals periodically. In the absence of agreement, small alarm devices emitting sound similar to the prescribed audible alarm signals and having limited range should be used during exercises to keep personnel familiar with the audible alarm signals.

Note (1). No reference is made to ground attack in order to reduce to a minimum the numbers of signals. Signals for ground attack, if deemed necessary, remain the prerogative of field commanders.

IMPLEMENTATION OF THE AGREEMENT

11. This STANAG will be considered to have been implemented when the necessary orders/instructions have been issued directing the forces concerned to put the content of this agreement into effect.

ANNEX A TO STANAG 2047 (2nd Draft) (Edition No. 5) ALARM SIGNALS

The following are alarm signals for NATO Forces operating on land:

TYPE OF HAZARD OR ATTACK	VISUAL ALARM SIGNAL	AUDIBLE ALARM SIGNAL
--------------------------	---------------------	----------------------

(Normal Flares Excluded)
(To be in accordance with
national instructions)

1. Imminent air attack	Red	a. Succession of long warbling signals, such as: (1) Unbroken warbling siren sound for one minute. (2) Succession of long (1) blasts on whistles, bugles or other wind instruments. (3) Series of continuous long (1) blasts on vehicle horn. (4) Vocal: "Air Attack" or corresponding national term where only one nation is involved.
2. Warning of imminent NBC hazards	Yellow or special audio-visual signal (2). Donning respirator and taking protective action followed by such hand signals as may be prescribed in local instructions.	Succession of short signals, such as: a. Rapid and continuous beating on any metal object or any other object which produces a loud noise. b. Succession of short (1) blasts on vehicle horn or other suitable device. c. Interrupted warbling sound on a siren.

3. The "all clear" or release from an alarm signal may be disseminated as follows:

All clear

No standard signal

a. Normally vocal:

"ALL CLEAR" by voice, radio, telephone or public address system.

b. A sustained signal, such as:

(1) Steady siren sound for one minute.

(2) Sustained blast on a vehicle horn, whistle, bugle or other wind instrument.

Notes.

1. For the purposes of this STANAG:

a. Long blast denotes 3 seconds on, 1 second pause.

b. Short blast denotes 1 second on, 1 second pause.

2. Produced from a single pyrotechnic device: a whistle sound followed by a closely coupled sequence of white, red, white lights.

Note. Automatic alarms for the early and rapid detection of biological and chemical agents, and radioactive fallout should, as far as possible, complement the devices referred to previously.

H-4. STANAG 2113: Destruction of Military Technical Equipment (Edition No. 3) NAVY/ARMY/AIR

ANNEX: A. Priorities for Destruction of Parts of Military Technical Equipment.

AIM

1. The aim of this agreement is to standardize procedures governing destruction of military technical equipment by the NATO Forces.

AGREEMENT

2. Participating nations agree:

a. That it is essential to destroy, to the maximum degree possible, military technical equipment abandoned on land or in harbor during wartime operations, to prevent its eventual repair and use by the enemy.

b. To follow the principles and priorities set forth in this agreement for the destruction of their own equipment when required.

GENERAL

3. Detailed Methods. Detailed methods of destroying individual items of equipment are to be included in the applicable publications, user handbooks and drill manuals.

4. Means of Destruction. Nations are to provide the means of destroying their own equipment.

5. Degree of Damage

a. General. Methods of destruction should achieve such damage to equipment and essential spare parts that it would not be possible to restore the equipment to a usable condition in the combat zone either by repair or by cannibalization.

b. Classified Equipment. Classified equipment must be destroyed to such a degree as to prevent the enemy from duplicating it or learning its method of operation.

c. Associated Classified Documents. Any classified documents, notes, instructions, or other written material concerning the operation, maintenance, or use of the equipment, including drawings or parts lists, are to be destroyed in a manner which will render them useless to the enemy.

PRIORITIES AND METHODS OF DESTRUCTION

6. General

a. Priority must always be given to the destruction of classified equipment and associated documents.

b. When lack of time or means prevents complete destruction of equipment, priority should be given to the destruction of essential parts, and the same parts are to be destroyed on all similar equipment.

c. A guide to priorities for the destruction of parts for various groups of equipment is contained in Annex A to this STANAG.

7. Equipment Installed in Vehicles. Equipment installed in vehicles should be destroyed in accordance with the priorities for the equipment itself, taking into account the relative importance of the installed equipment and the vehicle itself.

8. Spare Parts. The same priority for destruction of component parts of a major item must be given to the destruction of similar components in spare parts storage areas.

9. Cryptographic Equipment and Material. The detailed procedure for the rapid and effective destruction of all types of cryptographic equipment and material is to be specified in the instructions issued by the appropriate authority for security of communications.

10. Authorization. The authority for ordering the destruction of equipment is to be vested in divisional and higher commanders, who may delegate it to subordinate commanders when necessary. Standing orders should cover the destruction of isolated equipments which have to be abandoned on the battlefield.

11. Reporting. The reporting of the destruction of equipment is to be done through command channels.

IMPLEMENTATION OF THE AGREEMENT

12. This STANAG is considered to be implemented when the principles and priorities indicated herein have been incorporated in appropriate national documents.

**ANNEX A TO STANAG 2113 (Edition No. 3)
DESTRUCTION OF MILITARY EQUIPMENT**

**PRIORITIES FOR DESTRUCTION OF PARTS OF MILITARY
TECHNICAL EQUIPMENT**

EQUIPMENT	PRIORITY	PARTS
1. VEHICLES (INCLUDING TANKS AND ENGINEER EQUIPMENT)	1	Carburetor or/fuel pump/injector distributor/ fuel tanks/fuel lines.
	2	Engine block and cooling system.
	3	Tyres/tracks and suspensions.
	4	Mechanical or hydraulic systems (where applicable).
	5	Differentials/transfer cases.
	6	Frame.
2. GUNS	1	Breech, breech mechanism and spares.
	2	Recoil mechanism.
	3	Tube.
	4	Sighting and fire control equipment (Priority 1 for Anti-Aircraft guns).
	5	Carriage and tyres.
3. SMALL ARMS	1	Breech mechanism.
	2	Barrel.
	3	Sighting equipment (including Infra-Red).
	4	Mounts.
4. OPTICAL EQUIPMENT	1	Optical parts.
	2	Mechanical components.
5. RADIO	1	Transmitter (oscillators and frequency generators) and IFF equipment.
	2	Receiver including IFF equipment.
	3	Remote control units or switchboard (exchanges) and operating terminals.
	4	Power supply and/or generator set.
	5	Antennae.
	6	Tuning heads.

6. RADAR AND OTHER
ELECTRONIC
EQUIPMENT

- 1 Frequency determining components, records, operating instructions, which are subject to security regulations, and identification material (Identification Friend or Foe (IFF)).
- 2 Antennae and associated components such as radiators, reflectors and optics.
- 3 Transmission lines and waveguides.
- 4 Transmitter high voltage components.
- 5 Control consoles, displays, plotting boards.
- 6 Cable systems.
- 7 Automatic devices.
- 8 Other control panels and generators.
- 9 Carriage and tyres.

7. GUIDED MISSILE
SYSTEMS

- 1 Battery fire control centers.
- 2 Missile guidance equipment (including homing systems).
- 3 Launchers including control circuits.
- 4 Missiles.
- 5 Measuring and test equipment.
- 6 Generators and cable systems.

8. AIRCRAFT AND
SURVEILLANCE DRONES

- 1 Identification (IFF) equipment, other classified and electronic equipment, publications and documents pertaining thereto, and other material as defined by the national government concerned.
- 2 Installed armament (Use subpriorities for Group 2, Guns; or Group 3, Small Arms, as appropriate).
- 3 Engine Assembly (Priorities for destruction of magnetos, carburetors, compressors, turbines and other engine subassemblies to be determined by national governments, depending on type of aircraft involved and time available for destruction).
- 4 Airframe/control surfaces/under-carriage (Priorities for destruction of propellers, hub-rotor blades, gear boxes, drive shafts, transmissions, and other subassemblies (not already destroyed in Priority 3) to be determined by national governments, depending on type of aircraft involved and time available for destruction).
- 5 Instruments, radios, and electronic equipment (not included in Priority 1).
- 6 Electrical, fuel and hydraulic systems.

9. ROCKETS

- 1 Launcher.
- 2 Rocket.
- 3 Sights and fire control equipment.

H-5. STANAG 2154/QSTAG 539: Regulations for Military Motor Vehicle Movement by Road (Edition No. 4) NAVY/ARMY/AIR

ANNEXES: A. Definitions

B. Special Movement

RELATED DOCUMENTS:	STANAG 1059-	<i>National Distinguishing Letters for Use by NATO Armed Forces.</i>
	STANAG 2021-	<i>Computation of Bridge, Raft and Vehicle Classification.</i>
	STANAG 2024-	<i>Military Vehicle Lighting.</i>
	STANAG 2025-	<i>Basic Military Road Traffic Regulations.</i>
	STANAG 2041-	<i>Operation Orders, Tables and Graphs for Road Movement.</i>
	STANAG 2155-	<i>Road Movement Documents.</i>
	STANAG 2159-	<i>Identification of Movement Control and Traffic Control Personnel and Agencies.</i>
	STANAG 2174-	<i>Military Routes and Route/Road Networks.</i>

AIM

1. The aim of this agreement is to set out the basic regulations applying to military motor movement by road for the use of the NATO Forces.

AGREEMENT

2. Participating nations agree to use the regulations applying to military motor movement by road, defined in the following paragraphs, except where they are contrary to national laws and/or regulations.

GENERAL

3. It is particularly important that movement and transport staffs, who are responsible for international road movements and transport are trained to understand and use the terms and definitions listed in Annex A.

COLUMNS

4. A column is a group of vehicles moving under a single commander, over the same route, in the same direction.

5. A large column may be composed of a number of organized elements (formations, units or subunits).

6. Each column and organized element of the column should include:

- a. A commander whose location may vary.
- b. In the first vehicle: a subordinate commander known as the pace setter (AAP-6).
- c. In the last vehicle: a subordinate commander known as the trail officer (see Annex A).

7. The pace setter of the first element of a column leads it and regulates its speed. The trail officer of the last element deals with such problems as occur at the tail of the column.

8. In addition, each vehicle is to have a vehicle commander (AAP-6) (who may be the driver) who is to be the leader of the vehicle crew appointed for each mission. He is responsible for crew discipline and the execution of the mission.

IDENTIFICATION OF COLUMNS

9. Each column is to be identified in accordance with the laws or regulations of the country within which movement is taking place by flags and/or lights and, in some cases, by a movement number (see Annex A).

10. Each column which has received a movement credit (AAP-6) (see para 14 below) is to be identified by a number known as "the movement number" which is allocated by "the authority authorizing/arranging the movement." (See STANAG 2174.) This number identifies the column during the whole of the movement.

11. The movement number is to be placed on both sides and, if possible, on the front of at least the first vehicle and the last vehicle of each organized element of the column. It is to be permanently legible, from ground level, at a minimum distance of 6 meters in normal daylight and composed of:

- a. Two figures indicating the day of the month on which the movement is due to commence.
- b. Three or more letters indicating the authority organizing the movement, the first two letters being the national symbols of the column. (See STANAG 1059.)
- c. Two figures indicating the serial number (AAP-6) of the movement.
- d. One letter to identify the element of the column. (This is optional.) Example: Identification of 03-BEA-08-C will indicate that this is the 3rd day of the month, moved by BE authority 'A', as column No. 8, element "C".

12. Additionally, each organized element of a column is to be identified by flags and/or for night movement, by lights, security permitting, as described below:

- a. The first vehicle of each element of the column is to display a blue flag and a blue light at night if required by national laws or regulations of the country in which the vehicles are operating.
- b. The last vehicle of each element of the column is to display a green flag and a green light at night, if required by national laws or regulations of the country in which the vehicles are operating.
- c. The vehicle of the column commander is to display a white and black flag as indicated below, subject to the commander's discretion, in certain circumstances.



d. A vehicle that cannot maintain its position in a column should indicate this condition by displaying a yellow flag.

e. Flags should be approximately 30 cm (12 in) × 45 cm (18 in) in size.

f. Flags and lights are to be mounted on the front side of the vehicles.

13. Headlights. In peacetime, all vehicles driving in a column are to use dipped headlights (low beam), even in daylight.

MOVEMENT CREDIT

14. A Movement Credit is the allocation granted by the authority (See paragraph 10 above.) to one or more vehicles in order to move over a controlled route in a fixed time according to movement instructions (See STANAG 2174.), a controlled route being a route the use of which is subject to traffic or movement restrictions (AAP-6).

15. The Movement Credit includes the indication of times at which the first and the last vehicle of the column are scheduled to pass:

- a. The Entry Point. (See Annex A.)
- b. The Exit Point. (See Annex A.)
- c. Critical Points (See Annex A.) and, if possible, at Traffic Control Posts.

SPECIAL REGULATIONS FOR THE EXECUTION OF MOVEMENT

16. All personnel exercising a command in the column and all drivers must obey the instructions of traffic control and regulating personnel.

17. When approaching a traffic control or a regulating post indicated by prescribed signs (See STANAG 2025.) the column commander or his representative must advance ahead of his column and report to the post commander to:

- a. Give the required information concerning formation/unit, route and destination.
- b. Receive information and possible instructions.

18. Through this post, he can also arrange for the transmission of his own instructions, or information, to the various elements of his column as they pass the post, where however, they must not stop unless ordered to do so.

HALTS

19. Short Halts:

a. Short halts made by columns or elements of columns on controlled routes normally are to last 10 minutes and in principle should be taken after every 1 hour and 50 minutes running. Wherever possible all columns following the same route should stop at the same time but movement planning must, where necessary, allow at least a 10 minute column gap or gap between columns to ensure that a following column does not overtake the one in front while it is halted.

b. However, the characteristics of the road may make it necessary for the halt to take place in one particular part of the route rather than simultaneously at a fixed time. In such cases, the necessary instructions are given in the orders relating to the movement.

20. Long Halts. No standard rules for the observance of long halts are laid down. They must always be specifically plotted on movement graphs in order to avoid possible conflict.

21. Particular attention is to be paid to the following aspects of traffic discipline during halts:

a. When making a halt isolated vehicles, or vehicles forming part of a column, should move off the roads as much as possible.

b. If this practice cannot be observed, the commander of a column which is halted must take all necessary measures to facilitate movement of other road users and avoid accidents or traffic jams. The measures to be taken will vary according to the conditions and width of the road and should include:

(1) Warning at a sufficient distance from the front and rear of the column (guards, warning flags, lights or flares), security permitting.

(2) Organizing and directing a system of one-way traffic along the column.

c. When a halted column resumes movement, it has the right of way while moving back on to the road, unless otherwise prescribed.

OVERTAKING OF COLUMNS

22. By Isolated Vehicles

- a. An isolated vehicle is authorized to overtake a moving column only when:

C1, FM 6-50

(1) Its maximum authorized speed is appreciably higher than the speed at which the column is moving, thus enabling it to overtake each vehicle rapidly.

(2) There is sufficient distance between the vehicles of the column to allow the overtaking vehicle to regain its position in the proper lane after overtaking each vehicle.

(3) The trail officer of the column gives a clear signal that overtaking is possible.

b. In all other cases, an isolated vehicle is to overtake the column only when the latter is halted.

23. By Other Columns:

a. On a controlled route a column may overtake another column only on the orders of the movements authorities and as arranged by the traffic regulating personnel.

b. On an open route no column may overtake another moving column, except in special cases, e.g., on a one-way road which is wide enough. In these cases, the commander of the column desiring to pass is to contact the commander of the column to be passed prior to attempting to pass.

c. Outside these special cases, the overtaking of a column by another column is authorized only if the former is halted and provided the moving column has the time to overtake the whole of the halted column before the latter is ready to move. In this case, the commander of the column desiring to pass is to contact the commander of the column to be passed prior to attempting to pass. The commander of the halted column after giving his agreement, must facilitate the overtaking.

MOVING BY NIGHT

24. Normal conditions. By night, road movement is to be carried out in accordance with national laws and regulations of the country in which the vehicles are operating.

25. Emergency Conditions. See STANAG 2024.

ROAD MOVEMENT OF MOTOR VEHICLES/EQUIPMENT

26. The movement by road of certain outsize or heavy vehicles/equipment is restricted by limitations imposed by the different nations. These will call for the application of special procedures and, where necessary, specialized methods, to effect the movement of such equipment and vehicles whether loaded or not.

27. Annex B outlines, with regard to each nation, the class and gauge limits beyond which a road movement becomes a special movement.

IMPLEMENTATION OF THE AGREEMENT

28. This STANAG will be considered to have been implemented when the necessary orders/instructions to use the definitions and regulations contained in this agreement have been issued to the forces concerned.

ANNEX A TO STANAG 2154 (Edition No. 4) REGULATIONS FOR MILITARY MOTOR VEHICLE MOVEMENT BY ROAD

DEFINITIONS

1. Definitions already included in AAP-6:

a. Those concerning Time and Distance Factors in motor columns:

-Column Gap.

-Road Clearance Time.

-Traffic Flow.

-Traffic Density.

-Road Space.

-Pass Time.

-Average Speed.

b. Those concerning Formation and Dispersal of columns:

-Start Point.

-Release Point.

2. Definitions used for the purpose of this Agreement only:

-*Blackout Lighting*. A condition in which lights are so used that they cannot be spotted by enemy observation but which prevent collisions by showing the position of the vehicle to other road users.

-*Column Length*. "Column Length" or "Length of a Column" is the length of roadway occupied by a column in movement including the gaps within the column from the front of the leading vehicle to the rear of the last vehicle.

-*Column*. A group of vehicles moving under a single commander, over the same route, in the same direction.

-*Critical Point*. That point on a route where any restriction of traffic flow could cause disruption.

-*Road Movement Graph*. Used by the staffs in planning, supervising and regulating complicated road movements and for providing a convenient means of recording actual moves of units over a period.

-*Movement Number*. The numeric identification of a movement credit.

-*Normal Lighting*. Normal lighting is as prescribed or authorized by law of a given country without restrictions for military reasons.

-*Open Route*. Routes not subject to traffic or movement control restrictions.

-*Reduced Lighting (Vehicles)*. Reduced lighting implies that the brightness of all vehicle lights should be reduced by either reduction in power or by screening in such a way that any visible light is limited in output.

-*Special Movement*. The movement of outsize or heavy vehicles/equipment which is limited by legal restrictions of class or gauge of the host nation.

-*Traffic Post*. The post from which traffic control is operated.

-*Trail Officer*. A subordinate commander in each column of vehicles and each organized element of that column who deals with such movement problems that occur at the tail of the column/element of that column.

-*Vehicle Distance*. The space between 2 consecutive vehicles of a column measured from the front of one vehicle to the front of the vehicle following. Vehicle distance has a relation to density.

-*Entry Point*. The point where a column enters a controlled route.

-*Exit Point*. The point where a column leaves a controlled route.

ANNEX B TO STANAG 2154 (Edition No. 4)
REGULATIONS FOR MILITARY MOTOR VEHICLE MOVEMENT BY ROAD
SPECIAL MOVEMENT

INTRODUCTION

The expression "Special Movement" means movement of vehicles/equipment with or without load which, because of their class and/or dimensions, require special routing arrangements.

LIMITATIONS AFFECTING ROAD MOVEMENT

2. The conditions for the road movement of military equipment and vehicles are governed by the capabilities of existing road networks as defined in STANAG 2174. Further, the special regulations in force in the different countries place certain limitations on ordinary road movement of:

- a.* Individual wheeled or tracked vehicles, whether loaded or not.
- b.* Articulated vehicles consisting of a prime mover and semitrailer.
- c.* Articulated trains of vehicles consisting of a tractor and one or more trailers.
- d.* Passenger transport vehicles (motor coaches).

3. These limitations, details of which are given at Appendix L to this Annex for each country concerned with this agreement, relate to some or all of the following characteristics of the:

- a.* Width measured on any cross-section, including all projections.
- b.* Length (of vehicle or train of vehicles), including all projections and, where applicable, length of each part of the train: tractor + trailer(s).
- c.* Total height of the vehicle, including load, if any.
- d.* Turning radius.
- e.* Class of vehicle (or train of vehicles), calculated according to the method laid down in STANAG 2021.

RULES GOVERNING SPECIAL MOVEMENT

4. Any road movement of military equipment and vehicles of which one or more of the characteristics listed in paragraph 3 above exceeds the corresponding limitation(s) imposed by the regulations in force in any of the countries in which it will have to move (See Appendix L to this Annex.), constitutes a "special movement" in the country concerned.

APPENDIX 1 TO ANNEX B TO STANAG 2154

REGULATIONS IN FORCE IN NATO COUNTRIES AFFECTING THE ROAD MOVEMENT OF MOTOR VEHICLES EQUIPMENT

COUNTRY	Width including all projections	LENGTH OF VEHICLES				Motor Coach.	Total height (including load).	Turning radius.	Class (STANAG 2021).
		Single vehicles.	Articulated vehicle (prime vehicle and semi-vehicle).	Articulated train of vehicles (tractor & trailer(s)).					
				Total length of train.	Length of one UNIT.				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
BELGIUM	2.50 m	12 m	15 m	18 m	11 m	12 m	4 m	—	≤50
CANADA ¹²	2.50 m (8'6")	10.668 m (35')	15.24 m (50')	18.288 m (60')	12.192 m (40')	10.668 m (35')	3.81 m (12'6")	—	—
DENMARK	2.50 m	10 m or 12 m ²	14 m	18 m	10 m	12 m	3.60 m	—	≤35
FRANCE	2.50 m	11 m	15 m	18 m	11 m ¹	12 m	—	—	≤50
Fed. Rep. of GERMANY	2 50 m	12 m	15 m	16 m	—	12 m	4 m	—	≤50 ⁸
GREECE	2.50 m	10 m or 11 m ³	14 m	18 m	—	12 m	3.80 m	—	—
ITALY	2 50 m	12 m ³	15.50 m	18 m ⁹	12 m	12 m	4 m	12 m ¹⁰	≤50 ^{7 8}
LUXEMBOURG	2.50 m	5	15 m	20 m	11 m ³	12 m	4 m	—	≤40
NETHERLANDS	2.50 m	11 m	15 m	18 m	—	12 m	4 m	—	≤50 ⁴
NORWAY	2.50 m	12 m	15 m	18 m	—	12 m	3 m	—	≤50
PORTUGAL	2.45 m	10 m	12 m	14 m	10 m	10.30 m	4 m	—	≤50
TURKEY	2.50 m	10 m	14 m	16 m	—	11 m	3.80 m	—	—
UNITED KINGDOM	2.50 m	11 m	15 m	18 m	9.144 m	11 m	No Limit ¹¹	—	≤50
UNITED STATES	2.438 m (8')	10.668 m (35')	15.24 m (50')	18.288 m (60')	10.668 m ¹	12.192 m (40')	3.81 m (12'6")	—	≤50

¹Exclusive of coupling device on trailer.²Lorry with 2 axles: 10 m (32'8"); other vehicle: 12 m (39'4").³Motor vehicle with 3 or more axles: 11 m (36'1").

Motor vehicle with only 2 axles: 10 m (32'8") (ITALY – motor coaches excluded)

⁴Maximum tire – load: 5,000 kg (5 tons).⁵Vehicle with 1 axle: 7 m (23')

Vehicle with 2 axles: 10 m (32'8")

Vehicle with 3 axles or more: 12 m (39'4")

⁶Maximum load:a. Motor vehicles and trailers – with ground pressure 8 kg/cm²: 14,000 kg (14 tons) (2 axles);

18,000 kg (18 tons) (3 axles*); 22,000 kg (22 tons) (4 or more axles*).

*with a distance of 1 m (3'3") between two axles.

b. Buses: 15,000 kg (15 tons) (2 axles);

19,000 kg (19 tons) (3 axles).

c. Tractors and semi-trailers: 14,500 kg (14.5 tons).

Under the condition indicated in (a) above: 18,000 kg (18 tons) (3 axles); 28,000 kg (28 tons) (4 axles); 32,000 kg (32 tons) (5 or more axles).

d. In any case, maximum load on each single axle 10,000 kg (10 tons) on 2 axles (at a distance of 2 m (6'6")) 14,500 kg (14.5 tons).

⁷Highways only can be considered very heavy traffic routes (Class 12) but they cannot be used in peacetime by tracked vehicles.⁸Maximum load per single axle: 10,000 kg (10 tons).

Load on driving axle of vehicle: 16,000 kg (16 tons).

Authorized total weight is:

a. For single vehicles: 16,000 kg (16 tons) (up to 2 axles); 22,000 kg (22 tons) (with 3 or more axles).

b. For articulated buses: 28,000 kg (28 tons).

c. For tractors with semi-trailers: 38,000 kg (38 tons).

d. For trucks with trailers: 38,000 kg (38 tons).

⁹The total length should be less, if conditions of column No. 9 cannot be satisfied.¹⁰Each vehicle (single, articulated or train) should be included in a 5.30 m (17'3") wide circular crown of turning way. The internal radius of this circular crown cannot be longer than 12 m (39'4").¹¹No limit is imposed on height in the UK but on some secondary roads, bridges may give only 3.962 m (13') headroom, on main roads 4.572 m (15') is general.¹²a. Limitations in CANADA vary by provinces and designated highways. Generally in most provinces the size limits exceed the minimum limitations quoted.

b. In some provinces certain types of articulated trains are not permitted.

c. There are no limitations on turning radius.

d. Weight limitations are based on axle loads, axle spacing and tire size. They vary by provinces and designated highways. Restrictions on weight may be imposed during spring thaws.

e. For some designated highways there is a minimum speed restriction.

f. In peacetime, military authorities should check with provincial civilian authorities on limitations for vehicle road movement.

★APPENDIX I

INTERCHANGEABILITY OF AMMUNITION

I-1. General

Recently, there has been increased emphasis on interoperability between the US Army and its allies. A major consideration of interoperability is the degree to which our weapon systems can use the ammunition of our allies and vice versa. The purpose of this appendix is to show the field artillery ammunition components that are authorized/acceptable for exchange between the US and various allied nations during training and combat. This has been done through the use of charts, which will be described below. These charts will be updated in future changes to FM 6-50 and other manuals. Countries for which data are currently available are:

- a. Belgium (BE)
- b. Canada (CA)
- c. Denmark (DA)
- d. France (FR)
- e. Germany (GE)
- f. Italy (IT)
- g. Netherlands (NL)
- h. Norway (NO)
- i. Turkey (TU)
- j. United Kingdom (UK)
- k. United States (US)

I-2. Training

Chart 1 reflects the projectile/propellant charge combinations that are authorized for firing by US troops in training. Chart 1 and Chart 2, which provides the fuzes to be used, describe COMPLETE ROUND COMBINATIONS authorized for exchange by a Memorandum of Agreement signed by each nation. The charts reflect only the exchange of ammunition between the US and the listed nations and not exchange among the other nations. Additionally, A MIX OF COMPONENTS BETWEEN NATIONS IS NOT AUTHORIZED FOR USE BY THE US. For example, a German projectile cannot be used with a Canadian propellant charge for training.

I-3. Combat

Ammunition combinations acceptable for exchange ONLY DURING COMBAT are described in the appropriate STANAG. (See AAP-4.) Chart 3 describes the cartridge/feze combinations acceptable for exchange in combat for 105-mm howitzers. Charts 4a, b, and c show the projectile/propellant charges acceptable for exchange in combat for 155-mm, 175-mm, and 8-inch howitzers. When charts 3 and 4 are used in conjunction with chart 5, which depicts the fuzes acceptable for firing in combat, complete round combinations that can be exchanged in combat can be determined.

CAUTION: DO NOT MIX AMMUNITION COMPONENTS OF ONE NATION WITH ANOTHER. ADDITIONALLY, COMPONENTS IN CHARTS 3, 4a, 4b, 4c, AND 5 ARE TO BE EXCHANGED ONLY IN COMBAT.

Chart 1. Projectile/Propellant Charges Permitted by the US in Training (155-mm, 8-Inch, 175-mm) ^{1, 2}

CALIBER	US	BE	CA	FR	GE	NL	UK	NO
	M107/M3 M107/ M3A1	M107/ M3	M107/ M3 M107/ M3A1	M107/ M3	DM21/ DM62	M107C1/ M3C1 M107B1/ M3C1	M107/ M3A1	NM28/ NM23 M107/ NM23
155-MM	M107/ M4A1 M107/ M4A2	M107/ M4A1	M107/ M4A1 M107/ M4A2	M107/ M4A1	DM21/ DM42B1	M107C1/ M4A1 M107B1/ M4A1	M107/ M4A2	NM28/ NM23 M107/ NM23
8-INCH	M106/M1 M106/M2	M106/ M1 M106/ M2			DM11/ DM12 DM11/ DM22	M106/M1 M106/ M1C1 M106/M2 M106/ M2C2	M106/ M1 M106/ M2	
175-MM	M437A2/ M86A2 M437A2/ M124				DM11/ DM22 DM11/ DM32 ³			

¹Weapons (US):

155-mm: M114, M114A1, M114A2, M109, M109A1, M109A2, M109A3, M198

8-inch: M110, M110A1, M110A2

175-mm: M107

²Use M82 primer only in M109 series and M198 howitzers.

Use MK2A4 primer only in M114 series howitzers.

Use M82 primer only in M110 series and M107 howitzers.

³Fire Zones 1 and 2 only.

Chart 2. Fuzes Permitted by US for Firing in Training (155-mm, B-Inch, 175-mm)

TYPE	US	BE	CA	FR	GE	NL	UK	NO
PD	M557	M557	M557	M557	DM241	M557/ M557C1	M557/ L85A2 L112A1	M557
	M572 ²				DM241			
MTSQ ¹	M564	M564						
VT ¹	M514A1		M514A1					

¹155-mm only²175-mm onlyChart 3. Cartridges/Fuzes Permitted by the US for Firing in Combat (105-MM)^{1, 2}

CTG/ FUZE	US	BE	CA	DA	FR	IT	NO	TU
HE/ MTSQ	M1/M564	M1/ M500S M1/ M520A1	M1/ M520A1	M1/ M500	M1/M500	M1/ M500S M1/M520	M1/ M500S M1/ M520S	M1/ M500S M1/ M520 M1/ DM113
HE/PD	M1/M557	M1/ M51A5 M1/ M557	M1/ M557	M1/ M51A5 M1/ M557	M1/ M51A5 M1/M557	M1/ M51A5 M1/M557	M1/ M51A5	M1/ M51A5 M1/ M557 M1/ DM211
ILL/MT	M314/ M501S M314A3/ M565	M314A1/ M501S M314S/ M565	M314S/ M565	M314S M565	M314S/ M501	M314S/ M501S M314S/ M565	M314S M501S	
SMK, GRN BE/MT	M84/M501 M84B1/ M501A1 M84S/ M565		M84S/ M501A1			M84S/ M501S	M84B1/ M501	
SMK, HC/MT	M84S/ M501A1	M84/ M501S	M84S/ M501A1	M84S/ M501A1		M84S/ M501S	M84B1/ M501A1 M84B1/ M54	M84/ M501S
SMK, RED/MT	M84S/ M501 M84S/ M501A1		M84S/ M501A1					

Chart 3. Cartridges/Fuzes Permitted by the US for Firing in Combat (105-MM)¹, ²—continued

CTG/ FUZE	US	BE	CA	DA	FR	IT	NO	TU
SMK, WP/PD	M60A1/ M557 M60A2/ M557	M60/ M51A5 M60/ M557	M60/ M557 M60A2/ M557	M60/ M51A5 M60/ M557	M60/ M51A5	M60S/ M51A5 M60S/ M557	M60/ M51A5 M60/ M51A4 M60/	M60/ DM211 M60/ M51A5 M60/ M51A4 M60/ M557

¹WEAPONS: M101, M101A1, M102

²All listed cartridges are issued fuzed. The round should be fired with the fuze issued with it.

Note. S = Series

Chart 4a. Projectiles/Propellant Charges Permitted by the US for Firing in Combat

(155-mm)'

TYPE	US	BE	CA	DA	FR	GE	IT	NL	NO	TU	UK
HE	M107	M107	M107	M107	M107	DM21	M107	M107C1 M107B2 M107	NM28 M107	M107	M107
	M3 M3A1	M3	M3 M3A1	M3 M3A1	M3A1	DM62	M3 M3A1	M3C1	M-3	M3	M3A1
	M107	M107	M107	M107	M107	DM21	M107	M107C1 M107B2 M107	NM28 M107	M107	M107
	M4A2	M4A1	M4A1 M4A2	M4A1	M4A2	DM42B1	M4A1 M4A2	M4A1 M4C3	M-3	M4A1	M4A2
WP	M110	M110	M110	M110	M110	M110	M110	M110	M110	M110	M110
	M3 M3A1	M3	M3 M3A1	M3 M3A1	M3A1	DM62	M3 M3A1	M3C1	M-3	M3	M3A1
	M110	M110	M110	M110	M110	M110	M110	M110	M110	M110	M110
	M4A1 M4A2	M4A1	M4A2	M4A1	M4A2	DM42B1	M4A1 M4A2	M4A1 M4C3	M-3	M4A1	M4A2



'Must use M82 primer in M109 series and M198 howitzers and MK2A4 primer in M114 series howitzers.

Chart 4b. Projectiles/Propellant Charges Permitted by the US for Firing in Combat (155-mm)

TYPE	US	BE	CA	DA	FR	GE	IT	NL	NO	TU	UK
S M O K E	M118B1/E1 M118	M116 M116B1	M118B1/E1 M116	M116E1	M116	DM25A1 DM25 DM35 DM45	M116	M116C1	M116	M116	
	M3 M3A1	M3	M3 M3A1	M3 M3A1	M3A1	DM62	M3 M3A1	M3C1	M-3	M3	
	M118B1/E1 M116	M116 M116B1	M118B1/E1 M116	M116E1 M116	M116	DM25A1 DM25 DM35 DM45	M116	M116C1	M116	M116	
	M4A1 M4A2	M4A1	M4A1 M4A2	M4A1	M4A2	DM42B1	M4A1 M4A2	M4A1 M4C3	M-3	M4A1	
I L L U M	M48A1/E1 M485	M485A2	M485A2 M485A1	M485A2							M485A2
	M3 M3A1	M3	M3 M3A1	M3 M3A1							M3A1
	M485A1/E1 M485	M485A2	M485A2 M485A1	M485A2							M485A2
	M4A1 M4A2	M4A1	M4A1 M4A2	M4A1							M4A2

*Must use M82 primer for M109 series and M198 howitzers.
Must use MK2A4 primer for M114 series howitzers.

Chart 4c. Projectiles/Propellant Charges Permitted by the US for Firing in Combat
(175-mm, 8-Inch)¹

CAL	US	BE	CA	DA	FR	GE	IT	NL	NO	TU	UK
175-mm	M437A2 M437A1							M437A1 M437C1			
	M124							M124C1			
	M437A2 M437A1						M437A1	M437A1 M437C2		M437E2	
	M86A2						M86A2	M86A1 NR12		M86	
	M437A2 M437A1						M437A1	M437A1 M437C1		M437E2	
	M86A2						M86A2	M86A1 M86A2 NR12		M86	
8-inch	M106	M106		M106		DM11	M106	M106 M106C1		M106	M106
	M1	M1		M1		DM12	M1	M1 M1C1		M1	M1
	M106	M106		M106		DM11	M106	M106 M100C1		M106	M106
	M2	M2		M1		DM22	M1	M2 M2C1		M1	M1

¹Must use M82 primer.

Chart 5. Fuzes Permitted by the US for Firing in Combat (155-mm, 175-mm, 8-Inch)

TYPE	US	BE	CA	DA	FR	GE	IT	NL	NO	TU	UK
PD ²	M557 ²	M557	M557	M557	M557	DM241 DM211	M557	M557 M557C1	M557 DM211		M557 L85A2
PD ³	M572 ³					DM241	M572 M572C1	M572		M572	M572 L112A1
CP ²	M78 ²	M78				DM71 DM71B1		M78			
PROX ⁴	M514A1 ⁴		M514A1				M514A1		NVT42		L78
MT ²	M565 ²	M565	M565	M565			M565	NR150			L92 ¹
MTSQ	M501 M501A1	M501A1	M501A1	M501 M501A1		DM53	M501A1		M501 M501A1	M501 M501A1	L81A2
MTSQ	M564 ²	M564	M564	M564			M564			M564	

¹For smoke only²155-mm/8-inch only³175-mm only⁴155-mm/8-inch/Zones 1 and 2 175-mm

★APPENDIX J

MAINTENANCE AIDS

J-1. Correspondence and OJT Programs

★Table J-1 is a list of some typical maintenance MOSs for which OJT programs may be necessary and the proponent agencies for these courses. The commander may wish to refer to DA Pam 351-20 for further correspondence courses.

★ Table J-1. Correspondence/OJT Programs

POSITION	COURSE TITLE	ADDRESS-APPLICATION OR CATALOG
Mechanic	Wheeled Vehicle Mechanic Correspondence/OJT Course Tracked Vehicle Mechanic Correspondence/OJT Course	Army Correspondence Course Program (191) US Army Training Support Center Newport News, VA 23628
Equip maint clerk	Equipment Maintenance Clerk Correspondence/OJT Course	
	Unit and Organizational Maintenance, Repair Parts Supply, and Storage Correspondence Course, Course 159	(101)
Power generator operator/mechanic	Power Generator Operations I, II, III, IV, and V	(051)
Battery motor officer	Motor Officer Course	(171)

★J-2. Maintenance Training Publications

The following publications are sources of information for an OJT program for personnel in the battery or battalion shop.

★ Table J-2. Maintenance Training Publications

PUBLICATION	TITLE
DA Pam 350-26-4	Track Vehicle Mechanic Course, Combat Vehicles, Armored Carrier, M113/M113A1

★NOTE: Refer to DA Pam 310-3 and DA Pam 310-4 for additional maintenance training publications that are applicable to specific battery or battalion maintenance shops.

★J-3. Operator Training

a. A good operator training program is frequently difficult to organize and operate. Knowing where to start can be of assistance to the commander. The DA publications required to conduct an operator's training program are listed in table J-3.

Table J-3. Driver Selection/Testing Publications

PUBLICATION	TITLE
AR 600-55	Motor Vehicle Driver-Selection, Testing and Licensing.
AR 600-58	Mechanical Equipment Operator-Selection, Training, Testing, and Licensing.
TM 21-300	Driver Selection and Training (Wheeled Vehicles).
TM 21-301	Driver Selection, Training, and Supervision; Tracked Vehicles.
FM 21-305	Manual for the Wheeled Vehicle Driver.
TM 21-306	Manual for the Tracked Combat Vehicle Driver.
TB 600-1	Procedures for Licensing Operators of Equipment Managed by the US Army Mobility Equipment Command.

b. A suggested list of tasks that may be used to train operator personnel prior to their being licensed is outlined below.

Table J-4. Vehicle Operator Qualification Tasks

PROSPECTIVE DRIVER'S NAME: _____

DATE COMPLETED INITIAL TESTING: _____

SECTION CHIEF: _____

TASK	REFERENCE	GO	NO GO	INIT
Perform before-operation checks and services on vehicle.	Operator's manual			
Perform during-operation checks and services on vehicle.	Operator's manual			
Perform after-operation checks and services on vehicle.	Operator's manual			
Prepare vehicle for tactical operations.	Operator's manual			
Prepare vehicle for operation in snow/ice.	Operator's manual			
Start the engine by using the vehicle's power source.	Operator's manual			
Start the engine by using auxiliary power from an outside source.	Operator's manual			
Start the engine of a vehicle by towing.	Operator's manual			

Table J-4. Vehicle Operator Qualification Tasks—Continued

TASK	REFERENCE	GO	NO GO	INIT
Start the engine of vehicle in extremely cold weather (real or simulated).	Operator's manual			
Operate a vehicle over various types of terrain.	Operator's manual, Unit SOP			
Operate a vehicle under blackout conditions.	Operator's manual			
Operate a vehicle while backing with a trailer.	Operator's manual			
Guide a vehicle during daylight by using hand and arm signals.	FM 21-60			
Guide a vehicle during the hours of darkness by using a flashlight.	FM 21-60			
Extinguish a fire in a vehicle by using emergency procedures.	Operator's manual			
Recover a mired vehicle by using expedient means.	FM 21-305, FM 20-22			
Troubleshoot malfunctions by using the operator's manual.	Operator's manual			
Inventory basic issue items.	Operator's manual			
Perform preventive maintenance on basic issue items.	Operator's manual			
Fill out DA Form 2408-1 (daily) for a day of operation.	TM 38-750			
Fill out heading of DA Form 2404 used to record results of operator's daily inspection.	TM 38-750			
Fill out DA Form 2404 for operator's daily inspection to indicate no new uncorrected faults discovered on vehicle.	TM 38-750			
Fill out DA Form 2404 for operator's daily inspection to annotate a fault the operator cannot correct himself.	TM 38-750			
Fill out operator's portion of DA Form 2400 for day of operation.	TM 38-750			
Fill out DD Form 518, Accident Identification Card.	FM 21-305			
Fill out SF 91, Operator's Report of Motor Vehicle Accident, for simulated motor vehicle accident.	FM 21-305			

★ Table J-4. Vehicle Operator Qualification Tasks—Continued

TASK	REFERENCE	GO	NO GO	INIT
Perform ESC evaluation of vehicle.	ESC technical manual			
Record results of ESC evaluation on DA Form 2404.	ESC technical manual and TM 38-750			
Read vehicle lubrication order to specify lubrication points, intervals, and lubricants.	Vehicle LO			

Note. The individual being tested should actually perform the task stated if at all practical. Attendance at a class on the task does NOT necessarily indicate proficiency. The prospective driver should be allowed to use any reference he normally would have with the vehicle during dispatch (e.g., operator's manual, FM 21-305, lubrication order, and logbook).

The above named individual has performed the tasks specified above and is recommended as a wheeled/tracked vehicle driver.

(Signature of section chief)

(Date)

I have interviewed the above named individual, familiarized him with his duties as a wheeled/tracked vehicle driver, and recommend that he be issued this driver's license.

(Signature of Motor Officer)

(Date)

c. Additional aids the unit may wish to use while establishing the operator training program are listed below.

★ Table J-5. Driver Training Program Aids

PUBLICATION	TITLE
DA Pam 750-31	The M561 Gama Goat—Operation and Preventive Maintenance.
TB 9-2320-218-10-1	Safe Operation of Truck, Utility, 1/4-Ton, 4x4, M151 Series.

★J-4. Forms for Pinpoint Accounts

★ Table J-6. Forms of the DA Form 12-Series

DA Form Number	Title
12	Request for Establishment of a Publications Account.
12-4	Requirements for Department of the Army Administrative Publications other than Regulations and Circulars.
12-5	Requirements for Department of the Army Periodicals.
12-8	Requirements for Allied Communication Publications (ACP) and Joint Army, Navy, Air Force Publications (JANAP).
12-9A	Requirements for Department of the Army Unclassified Administrative Publications (AR's, CIR's, PAM's).
12-9B	Requirements for Department of the Army Administrative Publications (AR's, CIR's, PAM's).
12-11	Instructions for Completion of DA Form 12-11A and DA Form 12-11B (Army Doctrinal Publications) (FM).
12-11A	Requirements for Army Doctrinal Publications (FM).
12-11B	Requirements for Army Doctrinal Publications (FM).
12-12	Requirements for Tables of Organization and Equipment and Training Publications.
12-21	Requirements for Federal and Department of the Army Supply Catalogs.
12-21A	Requirements for Federal and Department of the Army Supply Catalogs.
12-25	Instructions for Completion of DA Forms 12-25A, 12-25B, 12-25C, and 12-25D (Technical Publications for Army Mobility Support, Construction, Environmental, Electrical Generating, Rail, Marine, and Amphibious Equipment).
12-25A	Requirements for Technical Publications for Army Mobility Support Equipment.
12-25B	Requirements for Technical Publications for Army Construction Equipment.
12-25C	Requirements for Technical Publications for Army Environmental Equipment.
12-25D	Requirements for Technical Publications for Army Electrical Generating, Rail, Marine, and Amphibious Equipment.
12-28	Requirements for Army Chemical Equipment Publications.
12-31	Requirements for Army Aviation and Army Avionic Configuration Publications.
12-32	Requirements for Army Missile, Rocket, and Air Defense Fire Distribution Systems Publications.
12-34	Requirements for Department of the Army Supply Bulletins.
12-34C	Requirements for Department of the Army Technical Bulletins.
12-34B	Requirements for Department of the Army Non-equipment Technical Manuals.
12-35	Requirements for Nuclear Weapons Publications.
12-36	Instructions for Completion of DA Form 12-36A (Avionics Publications).
12-36A	Requirements for Army Avionics Publications.
12-37	Requirements for Army Operation and Maintenance Literature for Combat Vehicles.
12-38	Requirements for Army Automotive Publications—Trucks.

Table J-6. Forms of the DA Form 12-Series—Continued

DA Form Number	Title
12-39	Requirements for Department of the Army Automotive Publications—Dollies, Trailers, and Semitrailers.
12-40	Requirements for Army Artillery, Small Arms, and Conventional Ammunition Technical Publications.
12-41	Requirements for Sighting and Fire Control Equipment Publications.
12-43	Requirements for Army Communications Security (COMSEC) Materiel Technical Publications.
12-50	Requirements for Army Radiac and Fixed Radio Equipment Technical Publications.
12-51	Requirements for Army Communication Electronics Equipment Literature.

★J-5. Suggested Minimum Motor Pool Library

Each battalion (battery) maintenance section should maintain a library of current maintenance publications for ready reference by operators and maintenance personnel. The following is a list of publications that are recommended for an effective maintenance program. Additional publications should be provided to meet special requirements.

a. Army regulations (AR).

- (1) AR 11-14, *Logistic Readiness*.
- (2) AR 55-29, *Military Convoy Operations in CONUS*.
- (3) AR 220-1, *Unit Readiness Reporting*.
- (4) AR 220-10, *Preparation for Oversea Movement of Units (POM)*.
- (5) AR 310-1, *Publications, Blank Forms, and Printing Management*.
- (6) AR 310-25, *Dictionary of United States Army Terms (Short Title: AD)*.
- (7) AR 310-50, *Authorized Abbreviations and Brevity Codes*.
- (8) AR 340-1, *Records Management—Program Policies and Procedures*.
- (9) AR 340-18-14, *Maintenance and Disposition of Logistics Functional Files*.
- (10) AR 385-10, *Army Safety Program*.
- (11) AR 385-30, *Safety Color Code Markings and Signs*.
- (12) AR 385-40, *Accident Reporting and Records*.
- (13) AR 385-55, *Prevention of Motor Vehicle Accidents*.
- (14) AR 600-55, *Motor Vehicle Driver—Selection, Testing, and Licensing*.
- (15) AR 600-58, *Mechanical Equipment Operator—Selection, Training, Testing, and Licensing*.
- (16) AR 700-4, *Logistic Assistance Program*.
- (17) AR 700-68, *Compressed Gases and Gas Cylinders*.
- (18) AR 710-2, *Materiel Management for Using Units, Support Units, and Installations*.
- (19) AR 735-5, *General Principles, Policies, and Basic Procedures*.

- (20) AR 735-11, *Accounting for Lost, Damaged, and Destroyed Property.*
- (21) AR 746-1, *Packaging of Army Material for Shipment and Storage.*
- (22) AR 750-1, *Army Materiel Maintenance Concepts and Policies.*
- (23) AR 750-20, *Prevention, Control, and Abatement of Pollution from Mobile Equipment.*
- (24) AR 750-37, *Sample Data Collection—The Army Maintenance Management System (TAMMS).*
- (25) AR 750-43, *Test, Measurement, and Diagnostic Equipment.*
- (26) AR 750-51, *Maintenance Assistance and Instruction Team (MAIT) Program.*
- b. Department of the Army Pamphlets (DA Pam).
 - (1) DA Pamphlet 310-1, *Index of Administrative Publications.*
 - (2) DA Pamphlet 310-2, *Index of Blank Forms.*
 - (3) DA Pamphlet 310-3, *Index of Doctrinal, Training, and Organizational Publications.*
 - (4) DA Pamphlet 310-4, *Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.*
 - (5) DA Pamphlet 310-6, *Index of Supply Catalogs and Supply Manuals (Excluding Types 7, 8, and 9).*
 - (6) DA Pamphlet 310-7, *Military Publications: US Army Equipment Index of Modification Work Orders.*
 - (7) DA Pamphlet 310-13, *Military Publications: Posting and Filing Publications.*
- c. Technical Manuals (TM).
 - (1) TM 5-461, *Engineer Handtools.*
 - (2) TM 5-725, *Rigging.*
 - (3) TM 9-237, *Operator's Manual: Welding Theory and Application.*
 - (4) TM 9-243, *Use and Care of Handtools and Measuring Tools.*
 - (5) TM 9-500, *Data Sheets for Ordnance Type Materiel.*
 - (6) TM 9-1000-202-14, *Evaluation of Cannon Tubes.*
 - (7) TM 9-2530-200-24, *Organizational, Direct Support and General Support Maintenance Manual: Standards for Inspection and Classification of Tracks, Track Components and Solid-Rubber Tires.*
 - (8) TM 9-2610-200-20, *Organizational Care, Maintenance and Repair of Pneumatic Tires and Inner Tubes.*
 - (9) TM 9-2610-201-14, *Standard and Criteria for Technical Inspection and Classification of Tires.*
 - (10) TM 9-4910-496-10, *Operator's Manual: Towbar, Motor Vehicle.*
 - (11) TM 9-6140-200-14, *Operator and Organizational Maintenance Manual for Lead-Acid Storage Batteries.*
 - (12) TM 9-8000, *Principles of Automotive Vehicles.*
 - (13) TM 21-300, *Driver Selection and Training (Wheeled Vehicles).*
 - (14) TM 21-301, *Driver Selection, Training, and Supervision; Tracked Vehicles.*
 - (15) TM 21-306, *Manual for the Tracked Combat Vehicle Driver.*
 - (16) TM 38-750, *The Army Maintenance Management System (TAMMS).*

- (17) TM 43-0139, *Painting Instructions for Field Use.*
- (18) TM 55-601, *Railcar Loading Procedures.*
- (19) TM 55-603, *Movement of Military Impediments by Commercial Carriers.*
- (20) TM 740-90-1, *Administrative Storage of Equipment.*
- (21) TM 750-116, *Organizational, Direct Support, and General Support Maintenance Procedures for Purging and Charging of Fire Control Instruments.*

Technical manual for each type of equipment supported.

Equipment serviceability criteria (ESC) manual for each type of equipment for which ESC is valid.

e. Miscellaneous publications.

- (1) Technical bulletins (TB), modification work orders (MWO), and lubrication orders (LO) for each type of equipment supported.
- (2) Unit Maintenance standing operating procedures (SOP).
- (3) Self-Service supply center catalog.
- (4) Direct exchange list.
- (5) Quick supply store catalog.
- (6) Direct Support Unit SOP.

f. Other publications.

- (1) FM 5-20, *Camouflage.*
- (2) FM 5-36, *Route Reconnaissance and Classification.*
- (3) FM 10-14, *Unit and Organization Supply (Manual Procedures).*
- (4) FM 10-69, *Petroleum Supply Point Equipment and Operations.*
- (5) FM 20-22, *Vehicle Recovery Operations.*
- (6) FM 21-6, *How to Prepare and Conduct Military Training.*
- (7) FM 21-11, *First Aid for Soldiers.*
- (8) FM 21-26, *Map Reading.*
- (9) FM 21-30, *Military Symbols.*
- (10) FM 21-60, *Visual Signals.*
- (11) FM 21-305, *Manual for the Wheeled Vehicle Driver.*
- (12) FM 29-2, *Organizational Maintenance Operations.*

(13) FM 29-25, *Direct Exchange, Shop Supply, and Operational Readiness Float Procedures.*

(14) SB 700-20, *Army Adopted/Other Items of Materiel Selected for Authorization/List of Reportable Items.*

(15) SB 740-98-1, *Storage Serviceability Standard: Tracked Vehicles and Component Parts.*

(16) TB 9-2300-402-10, *Air Pollution Control Procedures for Military Vehicles, Construction Equipment, and Materials Handling Equipment.*

(17) TB 9-2320-218-10-1, *Safe Operations of Truck, Utility: 1/4-ton, 4x4, M151 Series.*

(18) TB 43-0142, *Safety Inspection and Testing of Lifting Devices.*

(19) TB 43-180, *Calibration Requirements for the Maintenance of Army Materiel.*

(20) TB 600-1, *Procedures for Licensing Operators of Equipment Managed by the U.S. Army Mobility Equipment Command.*

(21) TB 43-0151, *Inspection and Test of air and Other Gas Compressors.*

(22) TB 750-231, *Overhaul Evaluation Policy for Towed and Self-Propelled Artillery Items, Mortars, and Recoilless Rifles.*

(23) TB 750-651, *Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems.*

(24) TM 38-L22-11, *Property Accounting and Army Equipment Status Reporting in divisions; Functional User Procedures and Codes.*

(25) TM 38-L22-15-2, *Class IX (Repair Parts) Supply System, Supply Operating Procedures, Using Unit Procedures.*

(26) TC 21-5-7, *Training Management in Battalions.*



★APPENDIX K

REFERENCES

K-1. Army Regulations (AR)

10 series	Organization and Functions
20-1	Inspector General Activities and Procedures
37 series	Financial Administration
75-1	Malfunctions Involving Ammunition and Explosives
220-45	Duty Rosters
230 series	Nonappropriated Funds and Related Activities
310-2	Identification and Distribution of DA Publications and Issue of Agency and Command Administrative Publications
310-25	Dictionary of United States Army Terms
310-50	Authorized Abbreviations and Brevity Codes
340-15	Preparing Correspondence
350-1	Army Training
350-30	Code of Conduct Training
350-212	Military Justice
350-216	The Geneva Conventions of 1949 and Hague Convention No. IV of 1907
350-225	Survival, Evasion, Resistance, and Escape Training
351-1	Individual Military Education and Training
351-4	Management, Operation, and Support of the Defense Institute of Security Assistance Management
351-5	Army Officer Candidate Schools
351-20	Army Correspondence Course Program
380-5	Department of the Army Supplement to DOD 5200.1-R
380-200	Armed Forces Censorship
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100-5	Operations
100-15 (TEST)	Larger Unit Operations (<i>Note: Under revision as Corp Operations.</i>)
100-27	US Army/US Air Force Doctrine for Tactical Airlift Operations
100-50	Operations for Nuclear-Capable Units
101-5	Staff Officers' Field Manual: Staff Organization and Procedure (<i>Note: Under revision as Command and Control of Combat Operations.</i>)
101-10 series	Staff Officers' Field Manuals
*To be published.	

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9-238	Deepwater Fording of Ordnance Materiel
9-1300-200	Ammunition, General
9-1300-206	Ammunition and Explosives Standards
9-1300-251-20	Organizational Maintenance Manual (Including Repair Parts and Special Tool Lists): Artillery Ammunition for Guns, Howitzers, Mortars, Recoilless Rifles, and 40-mm Grenade Launchers
9-6920-357-10-2	Operator's Manual: Laser, Gunnery Trainer M55
9-6920-361-13&P	Operator, Organizational and Direct Support Maintenance Manual (Including Repair Parts and Special Tools List): Field Artillery Trainer Kits (With Field Artillery Trainer M31)
21-301	Driver Selection, Training, and Supervision; Tracked Vehicles
21-306	Manual for the Tracked Combat Vehicle Driver
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STANAG 2154/ QSTAG 539	Regulations for Military Motor Vehicle Movement by Road

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★APPENDIX L

FUTURE TRENDS

L-1. General

There are numerous doctrinal and materiel developments ongoing that will have a dramatic effect on field artillery cannon batteries. They range in scope from changes to tables of organization and equipment (TOE) to new weapon systems and munitions. In this appendix, a brief description of some of these developments and their effect on the firing battery are given. A complete discussion of these areas will be in future changes to FM 6-50 as they are implemented.

L-2. 3 × 8 Direct Support Field Artillery Battalion

The 3 × 8 DS FA battalion is a new organization for divisional 155-mm direct support battalions. The battalion consists of a headquarters and headquarters battery, a service battery, and three eight-howitzer firing batteries. The firing batteries are organized into a battery headquarters, consisting of mess, supply, and maintenance sections; a communications section; and two firing platoons. Each of the firing platoons has a platoon headquarters, four howitzer sections, and an organic fire direction center. This organization will greatly increase the flexibility of the firing batteries as they are organized to perform split battery operations, with each platoon capable of independent function. A training circular is being developed for units undergoing this reorganization. This TC will fully explain the operational concept.

L-3. Howitzer Systems

a. M198. The M198 is a 155-mm towed howitzer system that is currently being fielded as a replacement for the M114A1/A2 systems. It will fire all current and

developmental 155-mm US ammunition and has a 30,000-meter range with the M203 propelling charge and M549A1 rocket-assisted projectiles.

b. M110A2. The M110A2 is an M110A1 with a low-efficiency muzzle brake applied. The addition of the muzzle brake enables the M110A2 to fire the M188A1 propelling charge and the M650 rocket-assisted projectile to a range of approximately 30,000 meters. Additionally, there is an ongoing development effort to provide the M110A2 howitzer ballistic protection to enhance its survivability.

c. M109A2/M109A3. The M109A2/M109A3 are the results of an M109A1 product improvement program. They incorporate 18 product improvements that:

- (1) Increase reliability, availability, maintainability, and crew safety.
- (2) Increase onboard ammunition capacity to 36 complete rounds.
- (3) Redesign the weapon-mounted rammer.
- (4) Add a ballistic cover for the panoramic telescope.
- (5) Add a boresighting alignment device.

The M109A3 is the designation for fielded M109A1s that have been product improved at Army depots. M109A2 refers to new production howitzers that have had the improvements included during manufacture.

L-4. Field Artillery Ammunition Support Vehicle

There is an ongoing effort to develop an ammunition carrier to replace the M548. Known as the field artillery ammunition support vehicle, or FAASV, this vehicle will incorporate the following features:

a. On-vehicle materiel-handling equipment to allow resupply of the FAASV, from another source, and resupply of the howitzer from the FAASV. The handling equipment will be able to transfer pallets or individual rounds. This capability will greatly reduce crew manhandling of ammunition components.

b. Ballistic protection equivalent to an M109-series howitzer.

c. Increased reliability, availability, and maintainability.

L-5. Projectiles, Propelling Charges, Fuzes, and Fuze Setters

a. Projectiles.

(1) *XM712*. The XM712 projectile, or Copperhead, is a 155-mm cannon-launched guided projectile (CLGP) that will give the field artillery a point target indirect fire engagement capability. The round is fired from a howitzer and is guided onto its target by an observer with a laser designator. The round uses a shaped charge to defeat armored targets and has good fragmentation effects against soft targets. Copperhead has several unique characteristics when compared to other 155-mm projectiles. It is heavier and longer, has openings for fins and wings, has a unique container and pallet, has a plastic nose cone, and uses integral laser coding and timing switches.

(2) *Family of scatterable mines (FASCAM)*. There are four field artillery FASCAM projectiles being developed. They are all members of the 155-mm M483A1 ballistic family of cargo-carrying projectiles and use the base-ejection method to dispel their submunitions over the target area. The four projectiles are the M692 and M731, which deliver antipersonnel mines, and the M718 and M741, which deliver antitank mines. All four projectiles are used to deny the enemy the use of a certain area for a specific period of time. The size of the area to be denied is determined by the number of projectiles fired and the aiming points used, while the time period is determined by the type of projectile fired. The mine submunitions carried by each projectile have

factory-set self-destruct times, which are specified as "short" or "long." The M731 and M741 have short self-destruct times (less than 24 hours after activation), while the M692 and M718 have long self-destruct times (greater than 24 hours after activation). The actual self-destruct times are classified (see TM 43-0001-28-1). The general characteristics of the M692, M731, M718, and M741 submunitions are as follows:

(a) *M692/M731*. Each of these projectiles contains 36 antipersonnel mine submunitions. Shortly after the submunitions are ejected and come to rest in the target area, each mine extends trip wires, becomes armed, and initializes its factory-set self-destruct mechanism. Disturbance of any of the trip lines will cause the mine to function, projecting a spherical kill mechanism upward. The kill mechanism functions at 2 to 8 feet above the ground by exploding and projecting fragmentation. The mine will self-destruct if not activated within the factory-set lifespan.

(b) *M718/M741*. Each of these projectiles contains nine antitank submunitions. After ejection, and soon after landing on the ground, each mine is armed and its self-destruct mechanism is initialized. Upon sensing the proximity of a large metallic object, such as a tank, the mine functions. If a mine is not activated within its intended lifespan, it self-destructs. Additionally, a percentage of the mines in each projectile have antidisturbance mechanisms to discourage attempts at minefield clearing.

(3) *XM795*. The XM795 high-explosive projectile is being developed to replace the standard M107 HE shell. This new HE projectile will be 7 to 8 inches longer, have more explosive force, and have a steel body of a higher fragmentation than the M107 shell. This new projectile will be constructed so that it and the new family of 155-mm cargo-carrying projectiles will be ballistically similar to the M483A1 projectile.

(4) *M650 rocket-assisted projectile*. The M650 8-inch rocket-assisted projectile (RAP) is a new development in the 8-inch projectile family that will increase the range of the new 8-inch self-propelled howitzer M110A2.

(5) *M509E1*. The M509E1 is the 8-inch dual-purpose ICM projectile. It will provide the 8-inch system with increased lethality.

(6) *XM825*. The 155-mm XM825 projectile is being developed to replace the M110 white phosphorus and M116 HC projectiles. It uses the base-ejection method to expel white phosphorus saturated felt wedges over the target area. It will provide a quick and effective visual screen for 5 minutes, over a 125-meter frontage, under worst case conditions.

(7) *Low-cost indirect fire training round*. There is an ongoing effort to develop a low-cost indirect fire training round, or LITR, to be used during service firing. The LITR will significantly reduce the cost of firing, when compared to conventional ammunition, yet will provide the same realism to the firing battery. The round will be similar in appearance to a service round and will use a current propelling charge and an XM747 fuze; however, it will not have an explosive filler. Projectiles are being developed for 155-mm and 8-inch systems.

b. Propelling charges.

(1) *M203 propelling charge*. The M203 propelling charge is designed for use in the M185 (M109A1/A2/A3 howitzers) and M199 (M198 howitzer) 155-mm cannon tubes. It is currently compatible only with the M198 howitzer. Currently, it can fire the M483A1 DPICM projectile to a range of approximately 22,400 meters and the M549A1 RAP to a range of approximately 30,000 meters. It is being tested for compatibility with the M185 cannon.

(2) *M188A1 propelling charge*. The M188A1 propelling charge is a recent development which, when used in conjunction with the M650 rocket-assisted projectile, will give the M110A2 howitzer a range capability of approximately 30,000 meters.

c. M587/M724 electronic time fuzes and M36 fuze setter. The M587 fuze is an electronic time fuze for use with burster-type projectiles (e.g., HE) 105-mm or larger. The M724 is for use with base-ejection type projectiles (e.g., ICM) 105-mm or larger. Both

fuzes can be set from 0.2 to 199.9 seconds in 0.1-second increments. They are set in less than 1 second by use of the M36 electronic fuze setter. The time setting is retained indefinitely on the fuze unless reset. There is no limit to the number of times a fuze can be reset.

L-6. Viper

The Viper is a light antitank weapon (LAW) currently under development. It is the same size and weight as the M72 LAW but has greatly improved lethality, hit probability, and range capabilities. The expendable launcher has an effective range of about 500 meters. It will be issued as an item of ammunition on the same basis as the M72 LAW. The Viper can also be modified to fire a 35-mm subcaliber training round.

L-7. TACFIRE

a. The tactical fire direction system (TACFIRE) is a computerized fire support command and control system with a wide range of capabilities, which enable it to:

- (1) Provide rapid and secure communications.
- (2) Correlate target intelligence.
- (3) Perform technical and tactical fire control.
- (4) Provide for automated consideration of the commander's criteria.
- (5) Integrate new systems.
- (6) Automate the fire planning function.
- (7) Perform nuclear and nonnuclear target analysis.
- (8) Compute and store survey information.

b. TACFIRE equipment basically consists of two types of central computers and three types of remote terminals. The principal functions of the computers are tactical and technical fire control, while the remote

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terminals are used to communicate with the computers. The term "tactical fire control" includes evaluating targets and selecting units to fire, munitions to be used, and volume of fire. Technical fire control simply means the computation of firing data for a specific fire mission. The division-artillery-type computers at corps field artillery section, division artillery HQ, and FA brigade HQ are used for tactical fire control. The computer issued to an FA battalion is oriented on technical fire control but possesses a tactical fire control capability as well. The division-artillery-type computer has more components and a larger memory and can therefore be programed to handle more tactical functions than the battalion computer.

c. Remote terminals are issued to those elements of the fire support system that require access to the TACFIRE computer, such as FISTs and FSOs. They include the digital message device (DMD) and the variable format message entry device (VFMED). The battery display unit (BDU) is at each firing battery. This device receives and acknowledges operational data, such as fire commands. A more complete discussion of TACFIRE is in FM 6-1, *TACFIRE Operations*.

L-8. Battery Computer System

a. The battery computer system (BCS) will replace the FADAC now in use by field artillery cannon batteries and the battery display unit to be issued with TACFIRE. The BCS will dramatically increase the flexibility and responsiveness of the field artillery and its effectiveness within the fire support system.

b. The BCS consists of a computer and up to 12 gun display units (GDU). A GDU contains a section chief's assembly (SCA), a small handheld unit similar to a pocket calculator that stores complete mission data and allows the section chief to display that data, and two gun assemblies (GA) that display the quadrant and deflection. The GAs will be mounted for easy viewing by the gunner and assistant gunner.

L-9. Small Unit Transceiver

The AN/PRC-68 small-unit transceiver, or SUT, is a small, lightweight, short-range radio being developed for use in laying the battery, in convoys, in emergency fire missions, and when wire communications are not available. A vehicle mount for the SUT is being developed for self-propelled howitzers and fire direction centers. The basis of issue of the SUT will be one per howitzer section, fire direction center, executive officer (platoon leaders in 3 × 8 DS FA bn), and battery commander. The SUT will greatly enhance command, control, and communications in the firing battery and will be operated on the battery's own internal command/fire radio net.

L-10. Velocimeter

The XM-90 radar chronograph, or velocimeter, is a lightweight doppler radar designed for calibrating the muzzle velocities of all current cannon weapon systems. The unit is two-man portable, and consists of a carrying case, a display unit, an antenna unit, a test unit, connecting cables, mounts, and an operator's manual. The basis of issue for the XM-90 will be one per howitzer battery (two per battery in the 3 × 8 direct support battalion), with one mount per howitzer. The XM-90 is a very simple and rugged device that will eliminate the need for the M36 radar chronograph. With the XM-90 mounted on the howitzer, the muzzle velocity can be obtained virtually as soon as the weapon is fired.

L-11. Thermal Warning Device

The thermal warning device, or TWD, is a temperature sensor externally mounted to the recoiling part of the cannon. It will provide the howitzer crew with a continuous reading of internal cannon tube temperature and alert them when dangerous levels have been reached. This device will allow development of more precise misfire procedures and possibly will increase rates of fire. Rates of fire are limited by temperatures in the cannon tube, and since there was no way of

measuring this condition on the howitzer in the past, they were safe-sided. With the fielding of the TWD, rates of fire will be governed by the reading on the sensor. The TWD will offer an increase in crew safety and howitzer capability. It is currently on the M198 howitzer, and a development effort is ongoing to apply it to the M109 and M110 series howitzers.

L-12. Simplified Test Equipment for Internal Combustion Engines

The simplified test equipment for internal combustion engines, or STE/ICE, is a mechanic's tool to test vehicle engine and accessory systems. It is compatible with virtually all automotive systems in the Army inventory and can perform more than 45 types of tests and measurements by providing pass/fail indications or measurements in units familiar to the operator (psi, volts, ohms, amps, etc.) through a digital display.

L-13. Firefinder Radar Systems

a. The AN/TPQ-37 artillery-locating radar will provide locations of hostile

artillery and rocket launchers at their normal firing ranges with sufficient accuracy to permit immediate counterfire. The radar can also be used to register and adjust fire. The AN/TPQ-37 includes an S-250 operations control shelter carried on an M880 vehicle and an antenna mounted on an M832 dolly set and towed by a 5-ton truck that carries a 60-kilowatt, 400-hertz generator.

b. The AN/TPQ-36 mortar-locating radar is a highly mobile radar designed to automatically locate hostile mortars, near-in artillery, and other high-angle fire weapons. Its automation provides the capability of locating weapons firing simultaneously from multiple positions. The radar can also be used to register and adjust fire. The AN/TPQ-36 includes an S-250 operations control shelter carried by an M561, which tows the antenna trailer. A 10-kilowatt, 400-hertz generator is mounted on the antenna trailer.

c. Three AN/TPQ-36s and two AN/TPQ-37s are organic to the division artillery target acquisition battery. Division area coverage dictates that the firefinder systems be located in the vicinity of field artillery units. The systems will require security, survey, and logistical support from the supported unit.



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By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

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Brigadier General, United States Army
The Adjutant General

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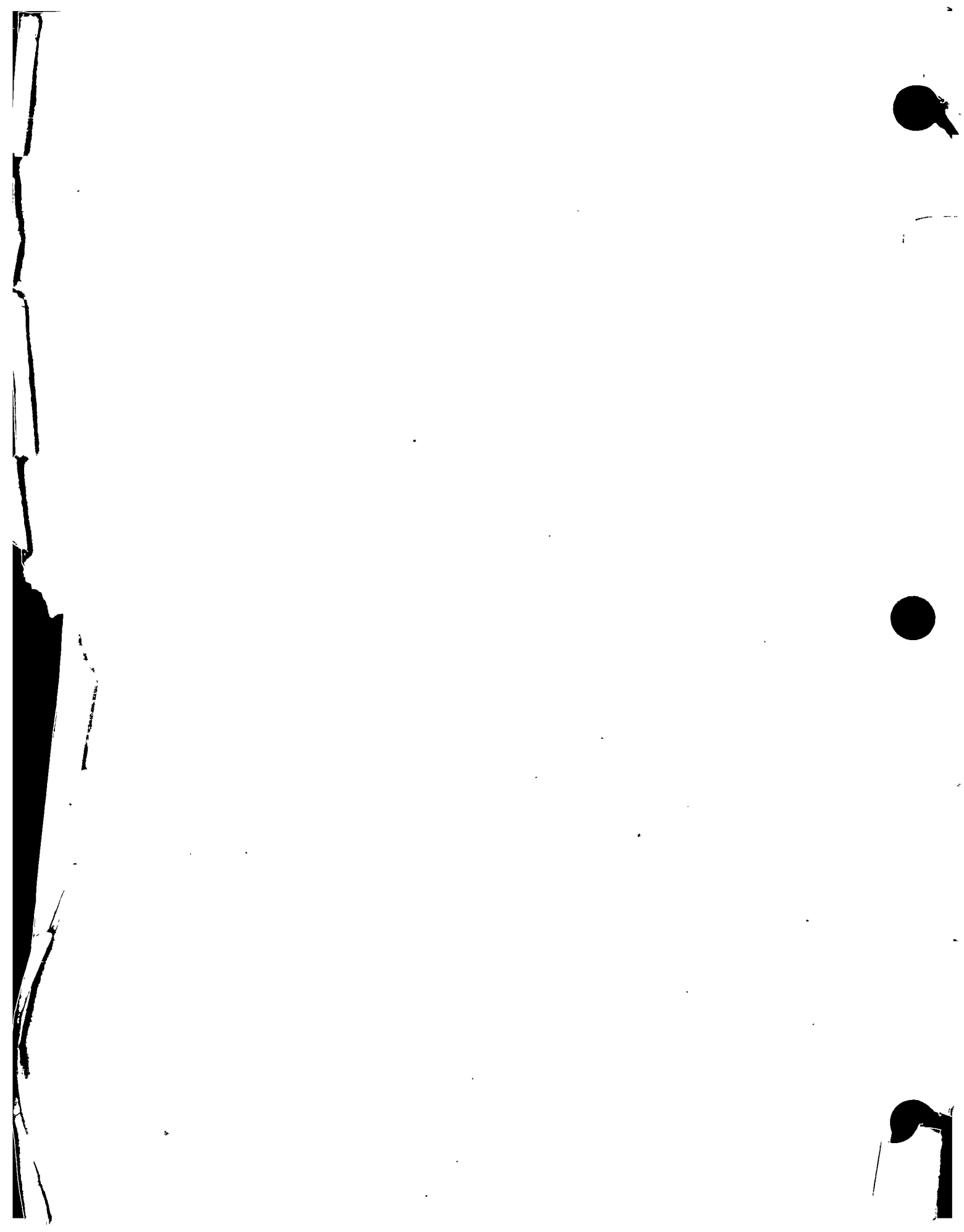
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**This manual supersedes FM 6-50, 1 July 1976.*

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This revised manual is designed to serve as the reference document for the cannon battery for both training and fighting. Its primary target audience is the cannon battery leader.

The purpose of this preface is to highlight the major areas of change in this "product improved" field manual. Additionally, pertinent ongoing and imminent TOE actions are discussed below.

Training

The most important aspect of the revision is the subject of *training*. To aid the battery leadership in making "train as we intend to fight" a reality, the following portions of the manual have been completely rewritten.

Chapter 16 discusses *development of the battery training program*, keying on the four-step training process of ANALYZE-PROVIDE-CONDUCT-EVALUATE. Throughout the chapter such training and evaluation tools as the ARTEP, Soldier's Manual (SM), Commander's Manual, Job Book, and Skill Qualification Test (SQT) are treated in terms of their utility in the programing and evaluation of training at all levels—individual, section, and unit.

Chapter 17 presents "*how-to-train*" techniques applicable to the cannon battery. It addresses training of the howitzer or gun sections, individual training in other MOSs, and progressive battery level techniques—ranging from the TEWT to a full-scale FTX.

Chapter 18 examines *maintenance procedures and training*, stressing preventive maintenance as a means to achieve readiness. The "tips" in the chapter itself are complemented by a new appendix I, containing a variety of tabulated maintenance aids.

Appendix C is a refined *cannon section evaluation* that may be used as a diagnostic tool, for crew training, or for section level competition.

Appendix D is an improved *gunner's qualification test*, designed to increase and maintain soldier proficiency on the weapon assigned. It is structured in terms of specific SM tasks.

Operations

Some changes have been made in part three of the manual, primarily to improve discussion of certain techniques.

Chapter 9 contains a more thorough treatment of *hasty survey* techniques, particularly directional traverse, simultaneous observation, observation of Polaris, and graphic resection.

Chapter 15 features a more complete discussion of *safety computations* (with examples), to include improved procedures for smoke, illuminating, and ICM computations.

Tactics

Although consideration of the enemy counterfire threat is not historically new, chapter 7 sets forth some detailed guidance on how to plan for *immediate actions* in response.

Equipment

TOE changes to permit establishment of the *battery operations center (BOC)* with its required communications are complete.

The *remote unit* C-2328/GRA-39 has been given a separate LIN to permit towed howitzer units to have the loudspeaker capability provided SP units by the LS-454.

To improve the ammunition-carrying capability of the battery, a recommended change to add M332 *ammunition trailers* (chapter 14) to TOEs has been forwarded.

The AN/PRC-68 radio, commonly called the *small unit transceiver (SUT)* will be added to TOEs as indicated in chapter 13. This will not only provide a backup intrabattery communications system, but will also greatly facilitate command and control.

In the future, a *velocimeter* will be added to the TOE of each cannon battery. The velocimeter is a metering system that determines the actual muzzle velocity of a given projectile by means of the doppler principle. This system—to be installed, operated, and maintained by the FA mechanic—will permit calibration in the battery position. Among its benefits are more accurate fires, decreased vulnerability through firing, and conservation of ammunition.

Organization

Two important organizational changes are reflected throughout the manual.

The *fire support team (FIST)* replaces the forward observer as the third member of the "gunnery team" in close support battalions. The FIST is assigned to the battalion headquarters.

The *CABL* concept—consolidation of administration at battalion level—is reflected to the extent that battery clerks and personnel functions have been consolidated at the battalion personnel administration center (PAC). It is likely that future actions will consolidate supply and dining facility personnel as well, while "permissive centralization" of maintenance will be the commander's prerogative.

The word "he" or "his" in this publication is intended to include both the masculine and feminine genders and any exception to this will be so noted.

CHAPTER 1

INTRODUCTION

1-1. Purpose

This manual has been prepared primarily for the cannon battery. However, many portions are equally applicable to headquarters and service battery operations. It is a how-to-train and how-to-fight manual—intended to guide the commander and his principal subordinates through the planning and execution of a sound training program and to assist in the fielding of combat-effective tactical units. It is designed for battery leaders, and should be used in conjunction with users' manuals for the appropriate weapon and other applicable field and technical manuals.

1-2. Scope

a. While FM 6-21 covers operations of the field artillery cannon battalion, to include the headquarters and service batteries, and FM 6-20 covers the entire spectrum of fire support in combined arms operations, this manual deals specifically with the basic fire support unit—the cannon battery.

b. This manual sets forth the responsibilities and duties of key personnel

for both training and fighting, and recommends methods by which the battery commander can best manage his equipment and personnel assets.

c. Additionally, it addresses doctrine and procedures for the cannon battery in offensive and defensive situations, and provides guides for the training and testing of section personnel.

d. Throughout this manual, discussion using the term "howitzer" has equal application to a gun unless otherwise stated.

1-3. Changes and Corrections

Users are encouraged to submit recommended changes and/or comments to Commandant, US Army Field Artillery School, ATTN: ATSF-TD-TM, Fort Sill, Oklahoma 73503. Comments should be keyed to specific page, paragraph and line. Rationale should be provided in support of comments to insure complete understanding and evaluation.

1-4. References

See appendix J for a list of references.



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CHAPTER 2

ORGANIZATION, MISSIONS, AND KEY PERSONNEL

Section I. ORGANIZATION AND TACTICAL MISSIONS

2-1. General

The mission of the field artillery is to destroy, neutralize, or suppress the enemy by cannon, rocket and missile fire and to integrate all supporting fires into combined arms operations. The field artillery cannon battery is the firing unit of the cannon battalion. It has the personnel and equipment necessary to move, shoot, and communicate. The cannon battery may operate as a separate tactical unit for limited periods of time. When the battery is operating independently, additional personnel and equipment may be attached to meet the requirements of the mission.

2-2. Organization

a. The organization of all cannon batteries is fundamentally the same (fig 2-1). Differences in organization stem from the caliber of the weapon, whether it is towed or self-propelled, and whether the battery is in a divisional or nondivisional battalion. The battery consists of the:

- (1) Battery headquarters.
- (2) Communications section.
- (3) Firing battery.

(a) Light and medium batteries (105-mm and 155-mm howitzer) have six cannon sections.

(b) Heavy batteries (8-inch howitzer and 175-mm gun) have four cannon sections.

- (4) Ammunition section.

b. The battery headquarters provides the personnel and equipment required to perform mess, supply, and maintenance functions for the battery. References covering these operations are in appendix J.

c. The communications section works with the battalion communications section to install and maintain communications for the battery.

d. The firing battery consists of the personnel and equipment required for determining firing data and firing the cannons. It includes the firing battery headquarters, the battery fire direction center (FDC), the battery operations center (BOC), and the cannon sections.

e. The ammunition section consists of the personnel and equipment necessary for battery ammunition resupply.

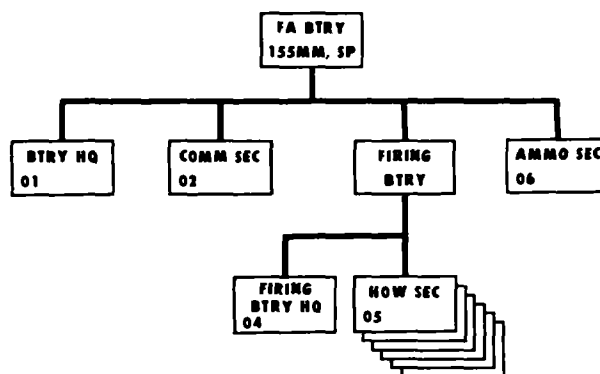


Figure 2-1. Typical cannon battery organization.

f. The field artillery battery of the regimental armored cavalry squadron (howitzer battery) is a modification of the typical battalion cannon battery. It is designed to function independently and to perform most of its own support functions. It is organized, trained, and equipped to operate in direct support of the armored cavalry squadron. A significant addition to the howitzer battery is the battery detail, which includes the communications section, a FADAC repairman, and a survey section. Also, the fire support teams (FIST) that support the squadron's maneuver elements are assigned to the battery.

2-3 Tactical Missions

a. When a cannon battalion is assigned a tactical mission of DIRECT SUPPORT (DS) of a brigade-size force, cannon batteries provide the fires to support that force. FISTS from the cannon battalion are provided to the companies/company teams of the supported unit.

b. When a cannon battalion is assigned a tactical mission of REINFORCING, GENERAL SUPPORT REINFORCING, or GENERAL SUPPORT, its batteries contribute reinforcing fires to other FA, or the

battalion provides fires for the force as a whole as directed by the force artillery headquarters. Details on communications requirements and other responsibilities are outlined in FM 6-10 and FM 6-20.

c. Additionally, the battery may function in a DEDICATED role. Dedicating the fires of a battery is an extension of the direct support mission. In a dedicated role, a battery provides fire support to a specifically designated maneuver company/team that is moving to contact. Fire planning considerations and techniques are discussed in FM 6-20.

Section II. DUTIES OF KEY PERSONNEL

2-4. Battery Commander

a. The battery commander (BC) is responsible for everything his command does or fails to do. Some specific responsibilities are listed below.

(1) Insuring that the battery accomplishes its mission.

(2) Training the battery for combat.

(3) Maintaining materiel and equipment.

(4) Maintaining high standards of discipline and morale.

(5) Preserving the health and physical fitness of the battery personnel.

(6) Insuring adherence to proper safety precautions.

(7) Performing reconnaissance, selection, and occupation of the battery position.

(8) Maintaining ammunition supply.

(9) Supervising the activities of the fire direction center (FDC), when necessary.

(10) Insuring the battery's survivability, to include proper concealment and adequate defense.

(11) Planning and controlling the unit marches and movements.

(12) Supervising the security, preparation, and delivery of special weapons, if applicable.

(13) Insuring that the battery functions in accordance with regulations and policies of higher commanders.

(14) Keeping the battalion commander and the personnel in his battery informed of the current situation.

(15) Establishing and maintaining a high degree of communications and electronics security.

(16) Managing the assignment of personnel within the battery.

b. In carrying out his command responsibilities, the battery commander:

(1) Plans his training program. He follows up on the progress of training by personally supervising and participating in the training.

(2) Makes frequent inspections to insure that his orders are being carried out; that living quarters are adequate and well policed; that food is appetizing, properly prepared, and served on time; and that routine work is equitably distributed.

(3) Makes himself available for

discussions with battery personnel on matters of a personal nature.

(4) Maintains discipline.

(5) Manages the assignment of personnel to insure the right man is placed in the right job.

(6) Insures the responsiveness of the personnel support system to the needs of the individual.

(7) Instructs and cross-trains key subordinates in their duties.

(8) Keeps his troops informed.

(9) Emphasizes the maintenance and proper use of all equipment.

(10) Insures application of the principles of supply economy.

(11) Assigns responsibilities and delegates authority to his officers and noncommissioned officers consistent with their positions.

c. The plans and orders of the battery commander are based on those received from the next higher command and his personal desires. These plans set forth a logical sequence for actions by each battery element in the accomplishment of the battery mission. The battery commander normally issues brief and informal oral orders. These orders fit specific situations and do not repeat standing operating procedures (SOP).

2-5. Executive Officer

a. The executive officer (XO) is the battery commander's principal assistant. During the BC's absence, the XO is the acting commander and assumes all the duties and responsibilities discussed in paragraph 2-4. When the BC is present, the XO ordinarily commands the firing battery portion of the battery. In some tactical situations, the XO may also perform the duties of the fire direction officer (FDO).

b. The XO is specifically responsible for:

(1) Supervising the battery as it occupies the firing position, and insuring the track plan is followed.

(2) Verifying the lay of the battery upon occupation of a position.

(3) Measuring and reporting piece direction as required.

(4) Determining the minimum quadrant elevation.

(5) Insuring that boresighting is accomplished as soon as possible and as often as necessary.

(6) Insuring that timely and accurate fires are delivered by the cannon sections.

(7) Insuring that before-, during-, and after-operation maintenance is conducted.

(8) Insuring that position area improvement (camouflage, hardening, etc.) begins as soon as possible and progresses at an acceptable rate.

(9) Insuring that ammunition is properly protected from the elements and enemy fire.

(10) Rendering the XO's report to the fire direction center (FDC). As soon as the information is available and without delaying the preparation of fire, the XO reports to the FDC that the battery is laid, and reports the common deflection, the minimum quadrant elevation for each charge, and the deflection and distance from the aiming circle to each piece.

(a) Sometimes, due to multiple crests, it is necessary to determine more than one minimum quadrant elevation for the sector of fire. In this case, the XO reports each minimum quadrant elevation and its related deflection (e.g., DEFLECTION 2850 to 3200, MINIMUM QUADRANT ELEVATION FUZES QUICK AND TIME, CHARGE 3 GREEN BAG, 100; DEFLECTION 3200 TO 3650, MINIMUM QUADRANT ELEVATION FUZES QUICK AND TIME, CHARGE 3 GREEN BAG, 104).

(b) When directed, the XO reports the amount, type, lot numbers, and weight of projectiles; powder temperatures; lateral limits of azimuth or deflection; maximum elevation when high-angle fire is to be used; and visible aiming points with referred deflections.

(11) Insuring that intrabattery communications are established as prescribed.

(12) Insuring that safe practices are observed, to include proper fire commands, safe firing data (not firing below minimum QE), and proper ammunition handling and storage.

(13) Insuring that each section chief knows the location of his supplementary position and that the route to this position has been reconnoitered.

(14) Coordinating with the first sergeant to determine sectors of fire for each howitzer to complement the overall battery defense plan.

(15) Supervising the development of range cards for howitzers and other crew-served weapons.

(16) Insuring that ammunition is distributed to the cannon sections according to anticipated needs determined by the FDC.

(17) Insuring in coordination with the FDC that a standby (hot) platoon has been designated for instant reaction to a fire mission.

(18) Training and supervising the activities of the firing battery.

2-6. Assistant Executive Officer

a. The assistant executive officer (AXO) performs duties as prescribed by the XO. He is normally charged with the responsibility of supervising the FDC. He must also be thoroughly familiar with the duties and responsibilities of the XO (para 2-5), since he may perform all or part of these duties in some situations. During 24-hour operations, the AXO and XO will normally divide the responsibility of supervising the FDC.

b. The functional job title of fire direction officer (FDO) is used to refer to the officer performing that duty. The FDO is specifically responsible for:

(1) Insuring the accurate and timely production of firing data.

(2) Assigning duties to personnel in a

manner that facilitates continuous operation, in shifts if necessary.

(3) Insuring that before-, during-, and after-operation maintenance checks are performed on the section vehicle, radios, computer, and generators.

(4) Insuring that locations of friendly units, boundaries, and fire support coordination measures are prominently posted and kept current.

(5) Insuring the proper use and functioning of battery wire and radio nets.

(6) When necessary, deciding how to attack a target and issuing the fire order.

(7) Insuring that FDC records are complete and accurate.

(8) Insuring that data for prearranged fires are properly disseminated and understood by FDC and cannon section personnel.

(9) Inspecting the map and, if necessary, computing the minimum QE to intermediate crests not visible from the battery area.

(10) Insuring that the camouflage and position-hardening effort in the FDC area begins as soon as possible and progresses at a satisfactory rate.

(11) Insuring that accurate and complete fire commands are sent to the cannon sections.

(12) Insuring that the quadrant announced in each fire mission is not below the minimum quadrant elevation for visible or intermediate crests.

(13) Coordinating with the battalion S3 to determine the type and amount of ammunition to be requisitioned.

(14) Coordinating with the XO to insure that a hot platoon has been designated.

(15) Preparing the safety diagram and verifying the plotting of safety limits on the firing chart.

(16) Providing safety data to the cannon chiefs of section, and updating it as necessary.

RECORD OF MISSIONS FIRED				SECTION #3		DATE TODAY		PAGE / OF		AMMUNITION/FUZES ON HAND											
For use of this form, see FM 6-50; the proponent agency is US Army Training and Doctrine Command										HE	HE	WP	CM	LL	GB	WB	Q	TI	VT	TI	
										X	T	S	H	K	Z	Y	5 ₃	5 ₄	7 ₂	5 ₇	
										56	42	7	63	10	81	97	69	40	39	65	
STND DATA:				ADJ PIECE: #3 ① SH: HE LOT: XY FZ: Q																	
PIECES FOLLOW PIECES FIRE MOF	SP INSTR	SH	LOT	CHG	FZ	TI	DF	QE	METHOD FFE	AMMUNITION EXPENDED											
BA				5			3240	341	② VT I/E	①							①	①			
							3220	350		②							②	②			
B②						VT 23.0	3225	355		④							④	67		②	
	EOM									52							93			37	
BA			TY	4			2954	325	③ I/E	①							①	①			
							2979	311		②							②	②			
B③							2967	317		⑤							⑤	⑤			
	EOM									37							88	62			
B②		ICM	HY	6	TI	21.2	3158	269					②				②			②	
	EOM												61				86			63	

DA FORM 1 MAY 76 4513

REPLACES DA FORM 4199, 1 JAN 74, WHICH IS OBSOLETE.

Figure 2-2. DA Form 4513, Record of Missions Fired.

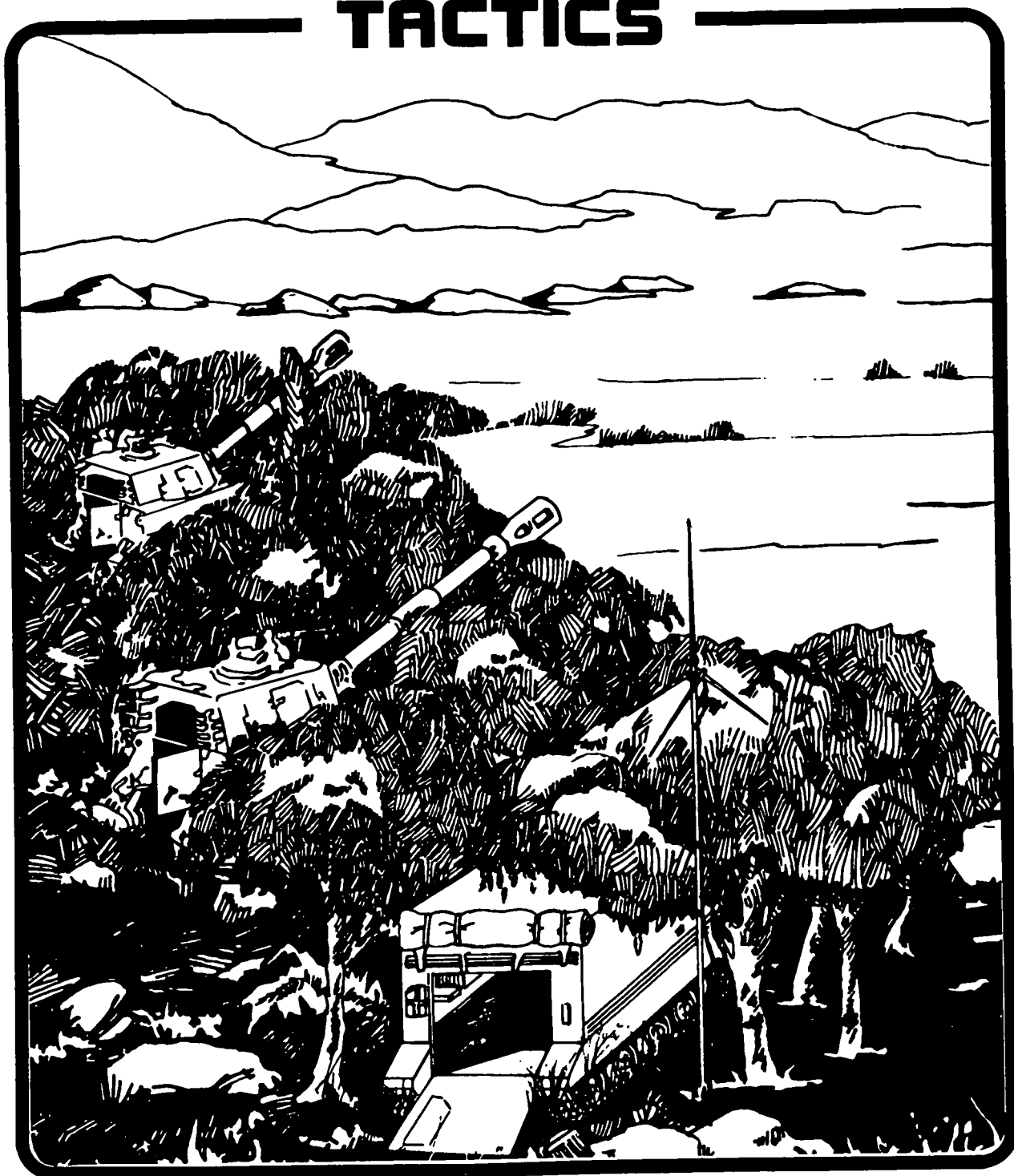
FM 6-50

GUNNER'S REFERENCE CARD										
AZ OF LAY										
DF TO AC					DIST TO AC					
DF TO COLL										
DF TO AP										
DF TO DAP										
MAX QE										
MIN QE										
STANDARDS			ADJ PIECE		SHELL		LOT		FZ	
PRIORITY TARGETS										
PRIORITY	TGT DESIG	SP INSTR	RDS	SH	LOT	CHG	FZ	TI	DF	QE
POSITION CORRECTIONS										
SECTOR		DF CORRECTION				QE CORRECTION				
PRIMARY										
LEFT										
RIGHT										

Figure 2-3. Gunner's reference card.

PART TWO

TACTICS



CHAPTER 3. RECONNAISSANCE AND THE ADVANCE PARTY

Section I. The RSOP, Page 3-3

Section II. Reconnaissance, Page 3-3

Section III. The Advance Party, Page 3-5

Section IV. Training, Page 3-7

CHAPTER 4. SELECTION AND ORGANIZATION OF THE POSITION AREA

Section I. Selecting the Position, Page 4-1

Section II. Organizing the Position, Page 4-2

Section III. Preparation for Occupation, Page 4-4

CHAPTER 5. MARCHES AND MOVEMENTS

Section I. Tactical Marches, Page 5-1

Section II. Preparation for Movement, Page 5-3

Section III. Conduct of the March, Page 5-5

Section IV. Miscellaneous, Page 5-7

CHAPTER 6. OCCUPATION OF POSITION

CHAPTER 7. DEFENSE OF THE BATTERY AREA

Section I. Introduction, Page 7-1

Section II. Organization of the Defense, Page 7-1

Section III. Conduct of the Defense, Page 7-10

Section III. THE ADVANCE PARTY

3-7. General

The method by which the battery displaces and occupies a new position, day or night, is greatly influenced by whether or not a reconnaissance can be made and by the time available.

3-8. Assembling the Party

For either a deliberate or a hasty occupation, a prearranged signal or procedure should be used to alert and assemble the advance party. The signal should be specified in the unit SOP, which should also list the personnel, equipment, vehicles, and place of assembly.

3-9. Organization of the Advance Party

a. Two vehicles are usually required to carry the advance party and its equipment. A suggested organization for a two-vehicle party is shown in table 3-1.

b. If the situation is such that the BC can provide only one vehicle for his advance party, basically the same personnel and equipment listed in table 3-1 can be carried in the M561 Gama Goat. If the BC has to reduce the organization, he can eliminate the optional communications chief or specify one gun guide per two howitzers.

3-10. Taking a Firing Capability Forward

Depending on the mission and tactical situation, the BC may take an M548 ammunition carrier, a howitzer section, or a platoon forward with the advance party. Reasons for taking howitzers forward may be:

a. To register from the new position or perform an offset registration from a position outside the new battery position area.

b. To provide fire support to forces not supportable from the old position.

c. To confuse moving target locating radars, as part of the infiltration plan.

3-11. Executing the Reconnaissance

a. Prior to departing for a new position area, the BC must give key information to his XO and advance party to provide continuity in the event he becomes a casualty. As a minimum, the BC should identify the—

- (1) Mission.
- (2) Method of motor march.
- (3) Route of march.
- (4) Tentative location of battery center.
- (5) Azimuth of fire.
- (6) Time of displacement.
- (7) General enemy situation.
- (8) Location of the release point.
- (9) Location of adjacent units.

The BC should also determine the tentative order of march of the howitzers before departure. He may also designate an alternate route if the primary route cannot be used.

b. After making a map reconnaissance, completing his planning, and briefing necessary personnel, the BC is ready to proceed to the new location. While moving, he verifies the suitability of the primary route. He also checks—

- (1) Cover and concealment.
- (2) Location of obstacles.
- (3) Likely ambush sites (plans on-call suppressive fires as required).
- (4) Time required.
- (5) Distance.
- (6) Likely position areas along the route.

c. If time allows the BC or another member of the party to return to the old position, he should check the alternate route.

d. Upon arrival at the new position area, the advance party should dismount rapidly and form a perimeter around the BC. The BC

then directs the 1SG to have the personnel sweep the area that he desires to look at more closely. Under the supervision of the 1SG, a sweep is made to insure that the area is free of enemy troops, boobytraps, mines, and nuclear, biological, and chemical (NBC) hazards. *Care must be exercised at all times to keep the advance party and its vehicles concealed.* As the advance party sweeps through the area, a skeletal perimeter is

established. This permits the BC freedom of movement after the sweep is completed. The sweep must cover the proposed position and also the surrounding terrain from which the enemy could attack.

e. During the sweep, the BC materializes the azimuth of fire on the ground, tentatively organizes the position, and formulates his plan of occupation.

Table 3-1. Suggested Advance Party

PERSONNEL	EQUIPMENT
Battery commander and driver	1 1/4-ton or 1/4-ton vehicle with radio, map, compass, and binoculars
First sergeant	Map, grid sheet, overlay paper, coordinate scale, protractor (for construction of defense diagram), and NBC kit
One battery operations center (BOC) representative	FDC equipment in BOC
Gunnery sergeant, assistant executive officer, or chief of firing battery	BOC vehicle with fire direction equipment, RC-292 antenna, declinated aiming circle with tripod and night lighting device, one SB-16, one telephone TA-312, and one light machinegun
Gun guides (one per howitzer)	Pantel marking and guide stakes, compass, communication wire (to reach from weapon to SB-16, when available), one set of aiming posts with night lighting devices, one axe, and one shovel.
Communications chief (optional)	Mine detection kit
Required route guides	
Note: When preparing for night operations, all personnel should have flashlights with filters.	
Suggested number of personnel for a six-weapon battery (less required route guides) = 12.	
Suggested number of personnel for a four-weapon battery (less required route guides) = 10.	

3-12. Major Tasks

Members of the advance party must be trained, both individually and collectively. Table 3-2 lists some of the major tasks to be accomplished by advance party personnel.

3-13. Training Program

A sound training program for an advance party can be conducted in three phases.

a. Phase I. During phase I, all personnel who might logically be expected to be members of the advance party are trained in the individual skills indicated in table 3-2. This training can be integrated into normal section training and should be highlighted whenever possible during other training.

b. Phase II. In phase II the battery commander conducts a tactical exercise without troops (TEWT) with key personnel of the advance party. Examples of how to use this technique are discussed in chapter 17.

This phase need not follow phase I, but the two phases might well be conducted simultaneously.

c. Phase III. Phase III is a rehearsal of the advance party in a simulated or an actual tactical environment. All the collective skills indicated in table 3-2 can be measured, critiqued, and reinforced during a rehearsal. The commander must make rehearsals as realistic as possible. Advance party members should be rotated frequently in order to cross-train as many people as possible. The standards in the appropriate ARTEP should be used as a guide for the conduct of this training.

During combat a unit maintains proficiency in those skills that are used day to day. If not used or practiced, skills that may be required later can be lost. Consideration should be given to conducting training during combat lulls. Such training will insure that a battery maintains its ability to perform all skills required.

Table 3-2. Advance Party Major Tasks

MAJOR TASKS	BC	XO	AXO	1SG	CFB	GSG	HOW SEC CHIEF	COMM CHIEF	BOC/ FDC	BC's DRIVER	HOW SEC PERSONNEL
1. Select a tactically sound battery position. (C)	X	X	X	X	X	X					
2. Select alternate and/or supplementary positions. (C)	X	X	X	X	X	X	X				
3. Select proper howitzer locations. (I, C)	X	X	X	X	X	X	X				X
4. Conduct a security sweep of new position area. (I, C)	X	X	X	X	X	X	X	X	X	X	X
5. Select locations for service vehicles (mess, maint, ammo). (C)	X	X	X	X	X	X					
6. Select a proper site for the BOC and FDC. (I, C)	X	X	X	X	X	X		X	X		
7. Set up and hook up wire to the SB-16 when available. (I, C)				X	X	X	X	X	X		X
8. Set up, level and orient the aiming circle on the azimuth of fire. (I, C)	X	X	X	X	X	X	X				
9. Aline howitzer guide stakes on an azimuth with the compass. (I,C)					X	X	X				X
10. Orient the aiming circle over the pantel marking stake and direct the emplacement of aiming posts. (I, C)	X	X	X	X	X	X	X				
11. Measure an initial site to crest using the aiming circle or an M2 compass.	X	X	X	X	X	X	X				

CHAPTER 4

SELECTION AND ORGANIZATION OF THE POSITION AREA

Section I. SELECTING THE POSITION

4-1. General

Having completed the route reconnaissance and arrived in the general area of the new battery position, the BC and his advance party conduct a sweep for enemy forces and prepare the position for occupation. Each member of the party must accomplish his job quickly and efficiently in order to insure maximum preparation for the arrival of the main body. The speed and smoothness of the actual battery occupation depend largely on the work of the advance party.

4-2. Considerations

The following are position selection considerations:

a. Mission. This is the most important consideration. The position should provide for fire throughout as much of the zone of influence of the supported maneuver force as possible.

b. Tactical situation. The tactical situation will largely dictate the location of the position area, the technique of positioning the howitzers and the use of terrain in defense of the battery.

c. Communications. The position must facilitate communications, particularly with fire support teams (FIST).

d. Defilade. Defilade is protection from enemy observation and direct fire weapons by use of a terrain mask. The battery should not be positioned so close to the mask that the unit low-angle fire capabilities are restricted.

e. Defensibility. The position should facilitate both active and passive defense so that it—

(1) Can be entered without enemy observation.

(2) Offers effective cover and concealment, with emphasis on concealment.

(3) Avoids high-speed approaches from the FEBA.

(4) Has more than one entrance and exit route, preferably in the rear of the position.

(5) Takes advantage of existing terrain features.

f. Trafficability. The soil must be firm enough to support the vehicles of the battery, especially the loaded ammunition vehicles.

g. Weather. Weather conditions and the effect of weather on the terrain must be considered.

4-3. Types of Positions

The BC must select three types of positions.

a. Primary position. The primary position is the position from which a battery intends to accomplish its assigned mission.

b. Alternate position. The alternate position is one to which the entire battery moves in the event its primary position becomes untenable or the battery has to move for other reasons. Since the battery will continue its mission from the alternate position, it must meet the same requirements as the primary position and should be far enough away that the battery can escape the effects of enemy indirect fire on the primary position. *It should be reconnoitered and prepared for occupation as time permits.* Each section chief must know the route to the alternate position, because movement to that position may be by section.

c. Supplementary position. A supplementary position is selected for accomplishment of a specific mission, such as for conduct of an offset registration, adjustment with a roving gun, or defense of the primary position.

(1) Supplementary positions for defense of the battery should be platoon sized, and

selected to cover likely enemy avenues of approach. Routes to these positions must be reconnoitered by all gun guides and section chiefs.

(2) Positions for *offset registrations* and

roving guns should be far enough from the primary position so that counterfire will not affect the primary position. The BOC will likely accompany the offset registering piece or roving gun. For more details, see FM 6-40.

Section II. ORGANIZING THE POSITION

4-4. Formations

a. Because of the ability of the enemy to detect the unit and react quickly, the commander must place more emphasis on concealment and survival than on positioning for best sheaf effects in the target area. A compact position is vulnerable to air attack and to counterfire. A straight-line formation presents an easy target for strafing or low-level bombing attacks. Both of these formations should be avoided.

b. Conforming to terrain patterns helps to conceal the position and provides better possibilities for firing to the flanks and rear. Terrain gun positioning should be the primary method of occupying a position area whenever possible. Terrain gun positioning is the use of terrain to provide the maximum concealment and protection from the enemy. It means fitting the howitzers to the rolls, folds, and vegetation of the occupied land mass. When the need for a 6400-mil firing capability is overriding and dictates the use of a small, tight, easily defended area, formations such as the star formation (fig 4-1) can be used.

c. Regardless of the type of formation, the howitzers are numbered from right to left and front to rear as they face the azimuth of lay

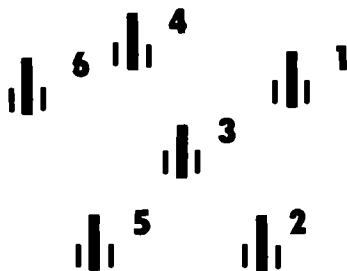


Figure 4-1. Star formation.

(fig 4-2). The howitzer numbers are assigned in each position and will *not* change as the azimuth changes.

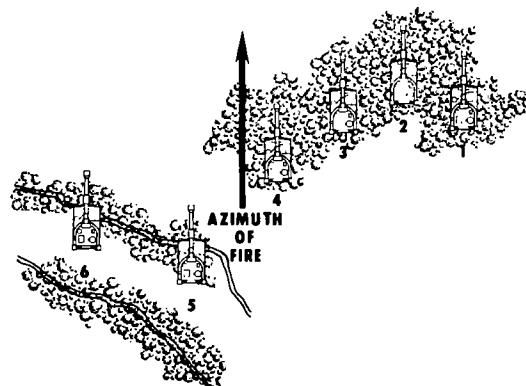


Figure 4-2. Howitzer numbering.

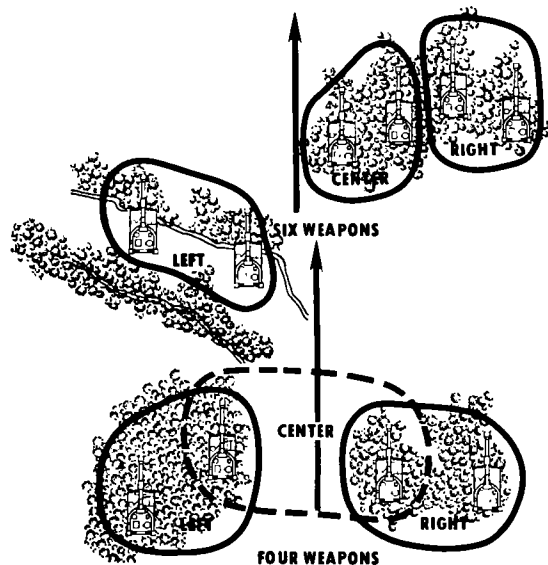


Figure 4-3. Platoon designations.

d. The howitzers are also divided into platoons. Each platoon has two howitzers, and the platoons are referred to as *RIGHT*, *CENTER*, and *LEFT* (fig 4-3).

e. Enemy attack capabilities may be so great and concealment so poor that either the battery must be spread over an abnormally large area or the howitzers must be grouped in small but scattered areas. Care must be exercised to insure that the area is not so large that the FDC cannot compute terrain gun position corrections (TGPC).

f. TGPC will provide acceptable effect on the target within the transfer limits provided that the battery position is within a box 400 meters wide and 200 meters deep. This box is centered over the battery center (BC) and oriented perpendicular to the azimuth of lay (fig 4-4). If the battery is more spread out than this, there will be less effect on the target within the stated transfer limits.

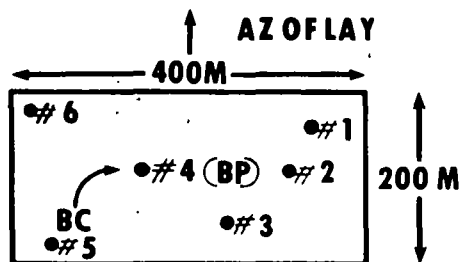


Figure 4-4. Battery position.

4-5. Battery Installations

a. Once the BC has selected the primary position, the advance party conducts a sweep and the BC tentatively selects positions for the howitzers and other battery installations.

(1) *Cannon sections.* An ideal position is one that provides defilade without unduly restricting the minimum elevation or sector of fire. Direct fire capabilities from the position should also be considered. The howitzers should be arranged to provide the best effects in the target area while taking advantage of natural cover and concealment.

(2) *Ammunition section.* The ammunition section area should be concealed and protected. It should allow easy access to supply routes. Ammunition is normally left on the vehicles to allow rapid displacement of the unit. If it must be off-loaded, it should be placed in an area that has good drainage. (Details on storage, care, and handling of ammunition are in chapter 14.)

(3) *Fire direction center.* The battery FDC should be located on a flank to minimize the effects of counterfire. The FDC must be able to communicate with the FISTs and battalion FDC. FM communications require electronic line of sight, so dead spots should be avoided if possible in selecting a firing position. Normally, a good map reconnaissance will reveal the positions where these dead spots are likely to occur because of line of sight.

(4) *Battery operations center (BOC).* The battery operations center serves as both the battery command post and the alternate fire direction center. It should be located as far as is tactically feasible from the primary FDC to reduce the possibility that hostile fire will damage both. The radios in the BOC may be remoted outside the immediate vicinity of the BOC in order to reach marginal locations. The RC-292 antenna should be erected, when required, to enable communications with distant stations.

(5) *Field storage location (FSL).* For units with a nuclear capability, the FSL should be located in the most defensible part of the battery position area consistent with the availability of natural concealment and access routes. Requirements for establishing the FSL are in FM 100-50, *Nuclear Unit Operations In Combat*.

(6) *Service area.* When support vehicles accompany the firing battery, a service area will be established. The service area contains the vehicle dispersal, maintenance, and battery mess areas. Since these installations are not directly related to the delivery of fire, they are located as far from the cannons as possible. The service area should be to the flank or rear of the cannons in an area that is accessible, that has firm ground, good drainage, cover, and concealment, and that provides adequate room for the dispersion of the vehicles. If terrain permits, vehicles should be separated by a minimum distance of 50 meters. All vehicles not required at the various battery installations should be parked in the vehicle dispersal area.

b. Figure 4-5 shows a typical battery position area.

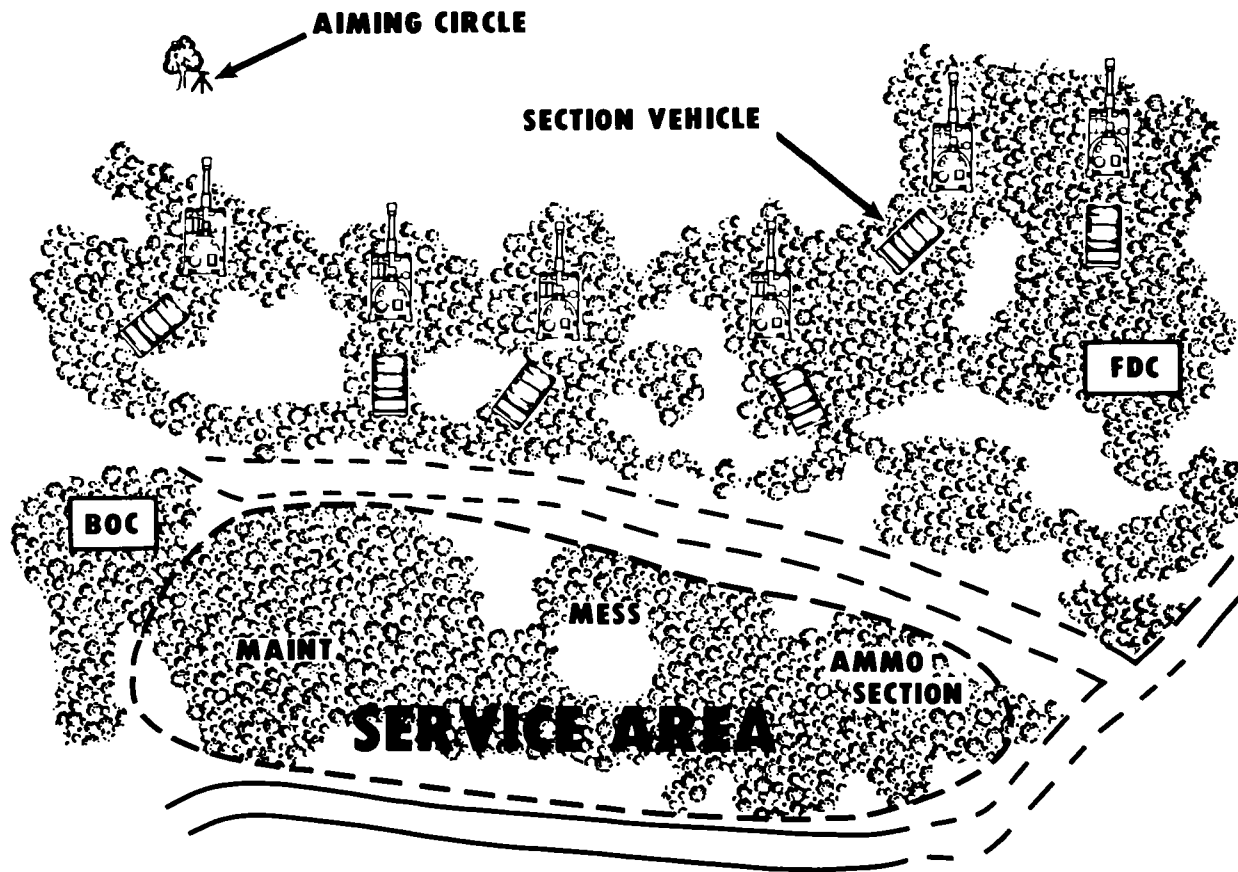


Figure 4-5. Type cannon battery position area.

Section III. PREPARATION FOR OCCUPATION

4-6. Preparation for Daylight Occupation

a. The BC finalizes his plan of occupation, giving priority to performing those tasks that facilitate immediate fire support to the supported maneuver force. The plan is not limited to, but should include, the following:

(1) The location of the base piece and other howitzers.

(2) The azimuth of fire, which the BC indicates by pointing out a terrain feature located on the azimuth or by pointing his vehicle in the direction of fire if a terrain feature is not available.

(3) Entrance and exit points. The BC indicates these points and provides guidance

to the 1SG for development of the battery track plan.

(4) The location of the battery installations such as the aiming circle, FDC, BOC, maintenance area, ammunition section, and mess area.

(5) Guidance on the scheme of defense.

(6) Location of the pickup point where the ground guides assemble to meet the battery. (Guides should not bunch up.)

b. As soon as the plan of occupation has been given, the key personnel begin performing their duties. Specific responsibilities are:

(1) The BC establishes the specific position of each howitzer.

(2) The gunnery sergeant sets up and orients the aiming circle—

(a) Away from magnetic attractions when laying by grid azimuth.

(b) Where it will have line of sight with the panoramic telescopes.

(c) Where it can be concealed.

As soon as the panoramic telescope (pantel) marking stakes (fig 4-6) are emplaced, the GSG announces the deflection to each pantel marking stake. The gun guides record this information and give it to the gunner and section chief when the battery arrives.

The GSG gives this deflection, along with the distance from each weapon to the aiming circle, to the BOC member for application to the M17 plotting board. If the BOC representative is unable to plot the piece displacement on the M17 plotting board before arrival of the FDC, the GSG gives the deflection and the distance from the aiming circle to each weapon to the FDO. The FDO uses these data in determining terrain gun position corrections (TGPC).

(3) Each gun guide—

(a) Emplaces the pantel marking stake in the location designated by the BC. The pantel marking stake marks the location of the panoramic telescope of the weapon.

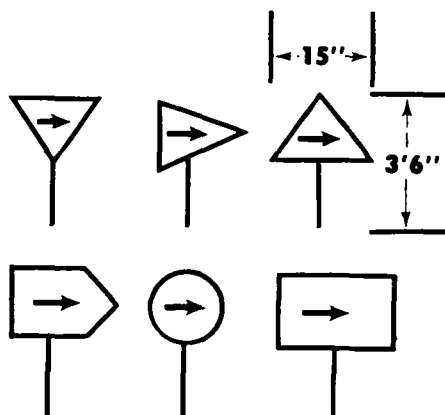


Figure 4-6. Pantel marking stakes.

Note. The arrow on each stake indicates the azimuth of fire.

(b) Aligns the front and rear guide stakes on the azimuth of fire so that when he guides the weapon into position the weapon will be on the azimuth of fire. In self-propelled (SP) units, the guide stops the weapon with the front roadwheel parallel to the front guide stake. This causes the panoramic telescope of the weapon to be over the hole left by the pantel marking stake. The proper emplacement of the pantel marking stake and guide stakes for SP units is shown in figure 4-7 and, for towed units, in figure 4-8.

(c) Receives and records the deflection to his pantel marking stake as read by the GSG.

(d) Paces the distance from his howitzer position to the aiming circle and reports the paced distance to the GSG. He doublechecks the paced distance by pacing back from the aiming circle to the pantel marking stake. Another means of determining distance from the aiming circle to each howitzer position is the subtense method. When this technique is employed—

The gun guide positions a 2-meter subtense bar (marked aiming post) over the pantel marking stake.

The GSG measures the subtended angle with the aiming circle, then records that angle next to the initial deflection for the position.

The BOC representative, using the subtense tables, converts the angles (provided by the GSG) into distances. (See chapter 9 for detailed procedures.)

(4) The BOC representative sets up the SB-16 and a firing chart as soon as the BC gives him the coordinates of the battery center and the azimuth of fire. If time permits, he also plots piece displacement on the M17 plotting board.

(5) The 1SG establishes the track plan, organizes the vehicle dispersal area, selects a position for each element in the service area, and plans the defense of the position. In forming the track plan, he considers the following:

(a) Existing roads and trails are important.

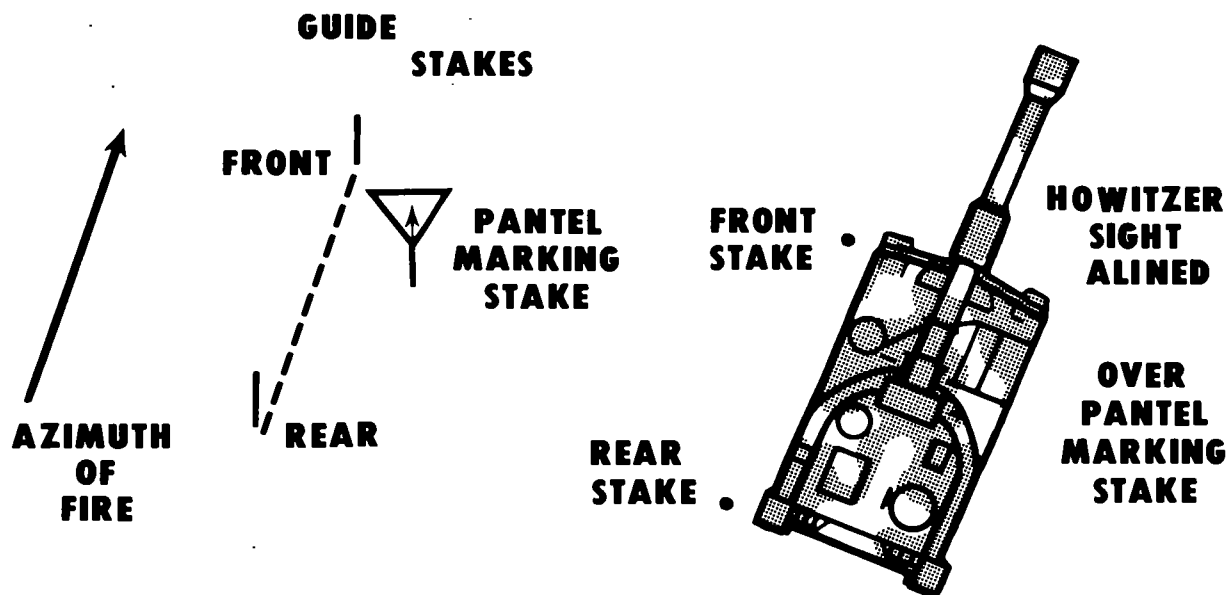


Figure 4-7. Use of stakes for SP weapons.

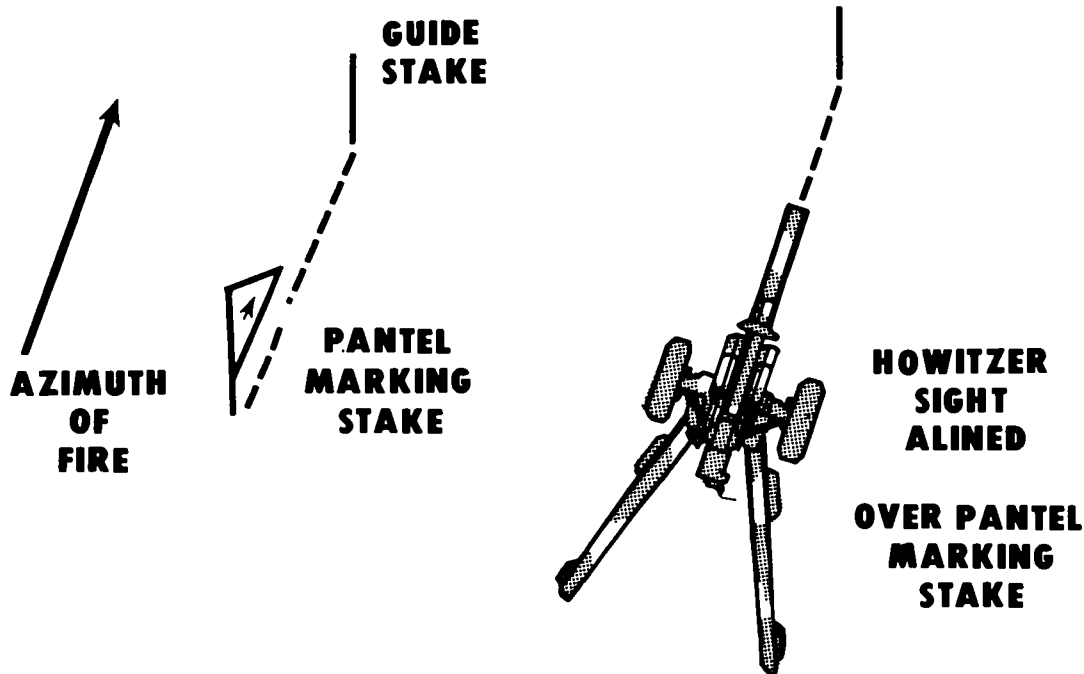


Figure 4-8. Use of stakes for towed weapons.

(b) The entry point to the position should be in the rear and at a location where foliage, trees, or other growth meets the main road or trail.

(c) Separate exit and entrance routes should be provided.

(d) Routes should follow natural terrain features such as gullies and tree lines and take advantage of natural overhead cover and concealment.

Vehicle guides are briefed on the track plan. If concealment is critical, the 1SG may dictate the exact route each vehicle is to follow. In SP units, situations in which sharp pivoting will disrupt ground cover must be avoided.

4-7. Limited Time Preparations

The following techniques are used in preparing the position when time is limited.

a. Duties are decentralized to the maximum extent possible. As soon as the BC selects the battery center, the gun guides select precise positions for their howitzers for approval by the BC. (The gun guides must be trained to select proper positions without

close supervision.)

b. One member of the advance party is left at the designated release point to guide the entire battery into position. Individual gun guides meet their respective vehicles as they approach their positions.

c. Service vehicles should be guided into position by the 1SG and the BC's driver. If necessary, vehicles may be repositioned as soon as time permits.

d. The BOC representative and the GSG conduct their normal duties to the extent that time permits.

4-8. Preparation for Night Occupation

In addition to what has already been discussed, there are other tasks that should be performed *as time permits* to facilitate a smooth and orderly night occupation.

a. The GSG and gun guides can emplace the aiming posts prior to darkness, after the gun guides have recorded the deflections from the aiming circle to their pantel marking stakes. Unit SOP must designate referred deflections for the howitzers to allow

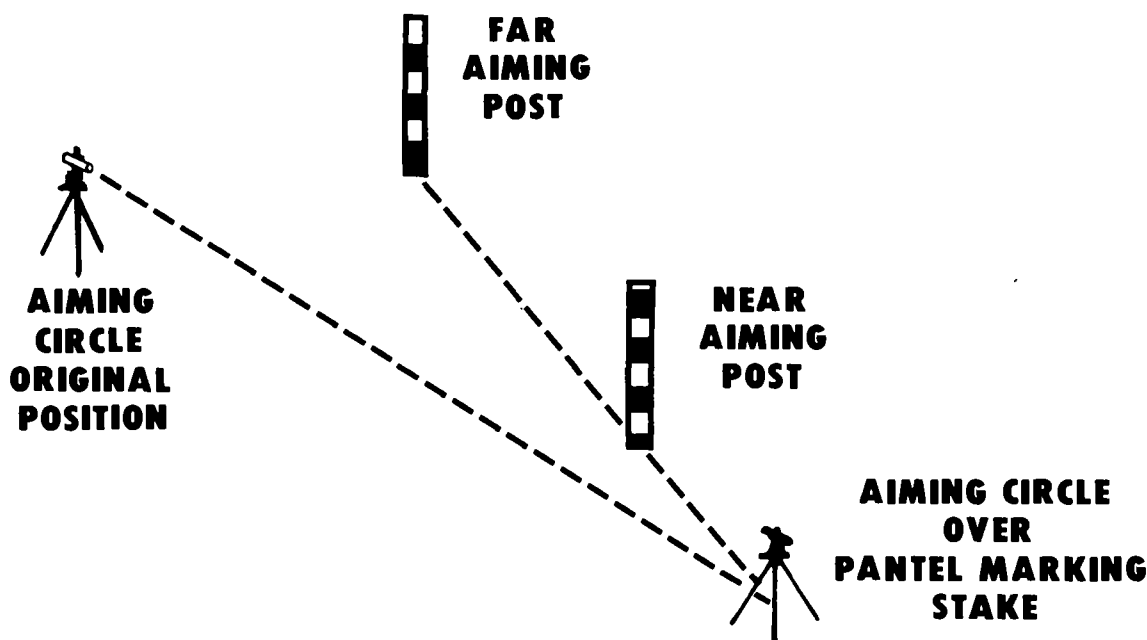


Figure 4-9. Emplacing aiming posts.

emplacement of aiming posts. The procedure for emplacing the aiming posts (fig 4-9) is as follows:

(1) After the GSG has read deflections to all pantel marking stakes, he marks the position of the aiming circle with a stake, a pole, or a section of an aiming post. (He does *not* use an aiming post section that has to be emplaced for any of the howitzers.) The GSG then proceeds to each howitzer position.

(2) He sets up, plumbs, and levels the aiming circle over the hole from the pantel marking stake over which the weapon sight will be positioned.

(3) With the *upper* motion, he sets off the deflection that he read earlier to the gun guide.

(4) With the *lower* motion, he sights on the stake (pole or aiming post section) emplaced at the original aiming circle position.

(5) With the *upper* motion, he sets off the deflection established by unit SOP for emplacing aiming posts.

(6) Sighting through the scope of the aiming circle, he then directs the gun guide to emplace the aiming posts. The night lights

must be mounted and in operating condition prior to emplacement. Unit SOP should specify the alternating of red and green lights between sections.

(7) While the aiming circle is still oriented over the pantel marking stake hole, he measures the site to crest. The GSG repeats steps (2) through (7) at the remaining howitzer positions.

b. For a night occupation *every* vehicle should be guided into the position. These guides must be thoroughly briefed and should pace their routes before and after darkness. They should be equipped with filtered flashlights or have reflective tape on the back of their helmets to guide the vehicles. In many instances, assistant drivers may be used as guides for night occupation. No vehicle should be allowed to move within the position at night without a guide.

c. If tentage is used in the battery, it should be erected prior to darkness. A check for light leaks must be made. If daylight shows inside the tent, then artificial lights will show outside the tent at night.

d. Light sets and their generators may be brought forward, installed, and *checked* prior to darkness.

(5) Extensive coordination is required to avoid traveling through other unit areas.

c. The battery employing the terrain march may move in open or close column, or by infiltration. Similarly, the battery can displace either as a unit or by echelon. When it moves by echelon, part of the firing element (possibly a platoon), a portion of the command and service element, and a portion of the FDC may move in the first echelon. The

remainder of the battery may move in the second echelon. This and other combinations insure continuous fire support and can be used in a split-battery and other types of operations. A modification of this technique would be to move non-mission-essential vehicles (mess, maintenance, supply) with the battalion headquarters. These vehicles can be moved in column or infiltrated to the battery position area at a later time.

Section II. PREPARATION FOR MOVEMENT

5-6. Orders

The details given in a march order depend on the time, the tactical and traffic situations, and the completeness of the unit SOP. (In a fast-moving, hostile situation many orders will be verbal.) The order may be supplemented by strip maps, sketches, and march tables. The principal items that should be included in a march order are—

- a. Situation.
- b. Mission.
- c. Destination.
- d. Organization, to include order of march and composition of the column.
- e. Instructions to the air observer (when applicable), reconnaissance parties, and route marking and control groups. Instructions should include place and time of departure, mission, special instructions for communications, and the time of rejoining the main body.
- f. Instructions to the main body to include the start point (SP), checkpoints (CP), designated rally point(s), the release point (RP) and times for arrival at and clearance of these points; rate of march; and the route.
- g. General instructions regarding restrictions on use of roads, maximum speed of march units, catch-up speeds, alternate routes and detours, and restrictions on use of lights and any special instructions regarding march discipline or defense against air or ground attack.

h. Communication instructions regarding the use of radio, messengers, flags, whistle or horn signals, pyrotechnic signals, and hand and arm signals.

5-7. Loading Plans

A loading plan prescribes efficient loading of personnel and equipment for movement. Each vehicle should have one. Loading plans are particularly important in sustained combat. Soldiers get tired and inattentive. They lose things. A good loading plan is insurance that a unit will close into the new position with all its equipment. The loading plan for a vehicle must be such that the equipment most essential to the mission will be loaded last. The loading plan should be recorded and graphically portrayed. Use of the loading plan is an indicator of training, discipline, and esprit de corps. If a loading plan is not prepared or specified by battalion headquarters, each battery should prepare its own. Personnel responsible for devising loading plans should consider the mission personnel, SOP, and equipment of the battery. Steps in preparing the loading plan include:

- a. Examining the battery table of organization and equipment (TOE) to determine the personnel, equipment, and vehicles authorized for each section.
- b. Examining all non-TOE property that must be transported by the battery. This equipment should be carried by the section responsible for its use.

c. Listing the personnel and equipment to be carried in each vehicle. Equipment should be located to facilitate identification under blackout conditions.

d. Conducting practice loadings to test the validity of the loading plan and adjusting the procedures if necessary.

e. Establishing a list of the items that must be removed from the vehicle and carried forward if the vehicle becomes disabled during movement.

5-8. Preparing for Movement

Preparation for the move may include:

a. Periodically starting vehicles to insure that batteries are charged and vehicles fully operational.

b. Taking up aiming posts.

c. Uncovering wire or removing it from trees.

d. Replacing section equipment in proper storage areas.

e. Reloading any off-loaded ammunition.

f. Removing overhead cover.

g. Completely loading all service elements; e.g., mess and maintenance.

CAUTION: THESE ACTIONS SHOULD NOT BE TAKEN UNTIL THE LAST MOMENT POSSIBLE. THE XO MUST KNOW HOW LONG IT TAKES HIS UNIT TO RECOVER AND BE READY TO MOVE.

5-9. Organization of the Column

The organization of the battery column varies according to the tactical situation, the threat, and the position area to be occupied. The following points should be considered:

a. In areas where enemy attack is probable, the cannons should be dispersed throughout the entire column.

b. Vehicles should be arranged in an order that facilitates speedy, organized occupation of the new position, and defense during movement and occupation.

c. If feasible, there should be two air guards per vehicle. One scans the sky forward of the vehicle while the other scans the sky rearward.

d. Machineguns should be distributed evenly through the column and should be aimed alternately to the left and right sides of the route of march.

e. Canvas should be removed as necessary to allow personnel to have their individual weapons poised to return fire if attacked. Individuals riding on the left side of a vehicle fire to the left; those on the right side fire to the right. In addition, SOP or other instructions should specify that some personnel fire on full AUTO and some on SEMIAUTO to maintain continuous fire.

f. Key personnel should be dispersed throughout the column to preclude losing a disproportionate number of these persons as a result of enemy action.

5-10. Convoy Control Measures

The following control measures assist in the movement of the battery.

a. *The start point (SP)* is normally a geographical feature identifiable on the ground and on a map. The first vehicle of a battery convoy must cross the SP at the specified start time. The battery is responsible for determining the route to the SP and the time it will take to get there. If the battery is displacing as part of a battalion move, the SP is also the point at which control of the marching element is normally assumed by battalion.

b. *A checkpoint (CP)* is normally a geographical feature identifiable on the ground and on a map. It is used in reporting progress along the route of march and may be used as a target when planning fires in defense of the convoy.

c. *The release point (RP)* is normally a geographical feature identifiable on the ground and on a map. The last vehicle of a battery convoy must cross the RP at the specified time. The battery is responsible for determining the route from the RP to the new position area. If the battery is displacing as

part of a battalion move, the RP is also the point at which control of the marching element is regained by the battery. The BC may send a vehicle from the advance party to the release point to lead the battery into the new position area.

d. A rally point is normally a geographical feature identifiable on the ground and on a map. It is used as a point of assembly and recovery from dispersion due to enemy attack. The designated rally point(s) should be located near or on the alternate route of march to the new position.

e. Marking the route aids in the move. The

route-marking detail marks the route by posting signs and/or personnel at those critical locations where elements of the march might make a wrong turn. Provisions are made to insure the prompt pickup of the route markers/guides when they are no longer needed. Details concerning traffic control and route marking are presented in FM 55-30 and FM 19-25.

f. Predetermined signals should be established by SOP to aid in convoy control. Such items as colored flags in daylight moves and flashlights at night can aid in simple but important communications within the column.

Section III. CONDUCT OF THE MARCH

5-11. March Discipline

a. Officers and noncommissioned officers ride where they can best control and supervise the march of their units. They usually ride where they can control the vehicle driver. The senior person in each vehicle is responsible for insuring that all orders concerning the march are carried out. To supervise the move, commanders and other designated personnel may require their vehicles to pass other vehicles in the column. All other vehicles maintain their positions until otherwise directed or until circumstances dictate otherwise.

b. The column must keep moving. The unit SOP should indicate who stops to pick up mission-essential personnel and equipment if a vehicle breaks down. In most cases, the driver stays with the vehicle and the maintenance section stops to assist. If the disabled vehicle cannot be repaired in a reasonable time or recovered by the battery, the position and condition of the vehicle are reported to battalion for recovery. The maintenance section must be prepared to proceed along the route of march independently as soon as possible in order to be available to the remainder of the battery. Accordingly, the maintenance section must have a map and must be thoroughly briefed concerning the route of march.

c. Each vehicle commander is responsible

for watching for signs, markers, signals, and other traffic. He is also responsible for insuring that the driver is alert at all times.

d. March discipline is attained through training and through internal control within the marching unit. The specific objective of march discipline is to insure intelligent cooperation and effective teamwork by march personnel. Teamwork includes:

(1) Immediate and effective response to all signals.

(2) Prompt relaying of all signals.

(3) Obedience to traffic regulations and to the instructions of traffic control personnel.

(4) Use of cover, concealment, camouflage, dispersion, radio listening silence, blackout precautions, smoke, and other protective measures against air, ground, armor, and chemical, biological, or nuclear attack.

(5) Maintenance of correct speeds, positioning, and intervals between vehicles within the column.

(6) Ability to recognize route marking signals/signs.

(7) Use of correct procedures for handling disabled vehicles.

5-12. Halts

a. During administrative marches, halts are made at regular intervals or at selected sites to rest personnel, to service the vehicles, and to check the loads. Normally, halts are not scheduled for tactical marches.

b. During extended vehicle marches (1 or 2 days) from rear areas to the main battle area, wooded areas and winding roads should be selected as halting places, since they provide concealment and do not present a straight line of vehicles for attack by enemy aircraft. During extended marches, halts should be made where vehicles can be dispersed off the road. Crossroads, railroads, and other similar places should be avoided. A column should be halted in an area that provides a 200-meter clear view of approaching traffic at each end of the column.

5-13. March Column Contingencies

a. Immediate action procedures. Because of the destructive power of field artillery, a battery must always assume that it is a very high priority target for the enemy. The nature of our weapons systems makes us most vulnerable to all kinds of attack while moving. If a battery establishes an SOP for immediate actions, based on what the individual section/vehicle is to do if attacked on the march, it can greatly decrease this vulnerability to attack. In establishing immediate action procedures, the BC or XO should consider—

(1) The enemy situation—what he can expect to be attacked with.

(2) His organic resources for countering the different types of attack.

(3) The nonorganic support available to him for countering attacks.

(4) The amount of time available for training the battery in the particular immediate actions (e.g., infantry squad tactics in response to a blocked ambush).

(5) The type of communications to be employed with the immediate actions—flags, radio, arm and hand signals, etc.

(6) How best to protect the battery.

(7) How best to neutralize the attack.

b. The march column under artillery attack. The immediate action in defense against hostile artillery fire is to *move out of the danger area*, report the situation to higher headquarters, and request immediate counterfire. If a battery expects hostile artillery fire during the march, it can reduce its vulnerability by moving—

(1) By open column or infiltration.

(2) Under the cover of darkness or during other periods of reduced visibility.

(3) By terrain march.

c. The march column under air attack. In the event of an air attack, the battery should engage the aircraft immediately with all air defense weapons available in the column and simultaneously disperse off both sides of the road and halt. A high-performance aircraft cannot be engaged effectively by leading it with low-volume, independent small arms fire. As the aircraft approach, everyone fires their weapons in the air to form a wall of bullets through which the aircraft must fly. For a detailed discussion of individual engagement techniques, see TC 23-44. The battalion Redeye section should have a copy.

d. Roadblocks. If the battery is halted by a roadblock, the maximum amount of fire power available, including howitzer direct fire, should be placed immediately on the roadblock and both sides of the roadblock. If nonorganic support, such as close air support, covering artillery or armor is available, it should be called on immediately to assist. If the roadblock cannot be neutralized, a disengagement must be effected under cover of supporting fires. The battery should, upon disengaging, meet at a designated rally point and resume its march using an alternate route. An attempt to crash through roadblocks with vehicles before it is checked for mines may result in unnecessary loss of equipment and personnel and a complete blocking of the road by disabled vehicles.

e. Ambush.

(1) There are two types of ambushes—

blocked and unblocked. Both must be countered in the same manner—*get out of the kill zone* and neutralize the ambushing force with firepower.

(a) *Blocked ambush.* If the route is blocked, maximum available fire should be placed immediately on the attacking forces. Personnel in the kill zone should immediately *dismount* and *attack* as infantry. Staying in the kill zone is the worst thing to do. The portion of the battery that is not in the kill zone must also *react immediately*. There are few ambushing forces that can equal the organic firepower of an artillery battery. *Use the howitzers* to place direct or indirect fire on the ambushing force (this should be SOP so that there is no delay while awaiting orders). Then roll up the flank of the ambushing force.

(b) *Unblocked ambush.* In an unblocked ambush, the battery should

increase its speed and move through the ambush area while placing the maximum amount of small-arms and automatic weapons fire on the attackers.

(2) A consideration in employment of the howitzers' main armament from the kill zone is that the targets may be too close for proper fuze action. Only the 105-mm APERS (Beehive) round can be set for muzzle action to engage targets close to the weapon.

(3) If the area was identified during the map inspection as a likely ambush site, on-call fires are executed. Otherwise, a fire request is sent immediately to the battalion FDC.

(4) If the ambush or any other enemy action is of such magnitude as to cause the column to be broken up, individual elements should proceed to the new position or designated rally points on their own.

Section IV. MISCELLANEOUS

5-14. Training

a. Training in convoy operations and counterambush measures should conform to the unit SOP. This will help insure that personnel are adequately trained to cope with situations that may confront them. Some considerations for establishing a training program are:

(1) Establish a realistic movement SOP. It should conform to battalion SOP and cover, as a minimum, the following:

(a) Approval authority for displacing the battery.

(b) Duties of convoy commanders.

(c) Convoy organization.

(d) Weapons and ammunition to be carried.

(e) Hardening of vehicles.

(f) Protective equipment to be worn by personnel.

(g) Preparation of vehicles (detailed instructions regarding tarpaulins, wind-shields, and tailgates).

(h) Counterambush action.

(i) Drills in reaction to air or artillery attack.

(j) Security measures.

(k) Maintenance and recovery of disabled vehicles.

(l) Any scheduled refueling and/or rest halts.

(m) Establishment of rally points.

(2) Stress estimating and maintaining the specified interval between vehicles especially if the column halts. Put interval marking signs on your motor pool exit to assist drivers in training.

(3) Teach the drivers to habitually evaluate the terrain in light of the cross-country mobility of their vehicles. Even to a well-developed area with a good road net, a driver may be required to make an off-road detour to bypass a roadblock or a section of damaged highway. The habit of constant terrain evaluation enables him to make a quick decision and select the most practical route, promptly.

(4) Practice terrain movement in small elements.

(5) Practice immediate action and critique it on the scene. Include vehicle breakdowns, equipment transfer, and vehicle repair/recovery in this action. (Many items in this area can be committed to your SOP.)

(6) Practice blackout movements to accustom the drivers to using the blackout lights. As they become proficient, restrict them to "cat's eyes" only.

b. Here are some tips for increasing the battery capability to conduct rapid and secure tactical vehicle marches.

(1) Do not limit training to those times when the entire battery is available. Whenever two or more vehicles are going to the same destination, conduct the movement as a tactical march.

(2) Find out how fast the battery can travel, both on and off the road, without losing the slowest vehicles. (Putting the slowest vehicles up front will automatically pace the column.)

(3) As a planning guide, on roads and trails the battery will average 25 km per hour in an open column and 10 km per hour in a close column (at night).

5-15. Other Movements

a. Detailed descriptions of the various other types of movements and marches (administrative, etc.) are given in the following manuals:

(1) FM 55-30 and FM 55-31, which include information on the organization of motor movements, the movement of personnel, and the planning of motor movements.

(2) FM 100-50, *Nuclear Unit Operations in Combat*.

(3) FM 101-10-1, which includes planning guidance for movements.

b. When the battery moves by rail, air, or water, it normally moves as an element of the field artillery battalion or with a supported unit. In any case, the battery receives detailed instructions in the form of a movement order or pertinent extracts from the movement order. A warning order alerts the battery and furnishes sufficient information of the impending movement for the battery to make plans and take the necessary preliminary action. The references listed below provide adequate information for the following types of movement:

(1) Movement by rail—FM 101-10-1 and FM 55-15.

(2) Movement by air—FM 1-100, FM 57-35, FM 100-27, FM 101-10-1, and TM 55-450-15.

(3) Movement by water—FM 101-10-1 and FM 55-15.

5-16. International Standardization Agreement

a. *STANAG 2041, Operational Road Movement Orders, Tables, and Graphs*. When the US Armed Forces operate with NATO Armed Forces, the instructions in STANAG 2041 will be followed. The applicable details of this agreement and instructions are contained in FM 55-30.

b. *STANAG 2154, Definitions and Regulations for Military Motor Movements by Road*. When US Armed Forces operate with NATO, SEATO, and CENTO Armed Forces, the instructions given in STANAG 2154 will be followed. This STANAG is explained in FM 55-30.

c. *SEASTAG 2024, Military Road Traffic Lighting Regulations*. When US Armed Forces operate with SEATO Armed Forces, the instructions in SEASTAG 2024 will be followed. Additional instructions are found in FM 6-36 and FM 19-25.

CHAPTER 7

DEFENSE OF THE BATTERY AREA

Section I. INTRODUCTION

7-1. General

Success on the battlefield by the combined arms team depends on the ability of the team to effectively combine its maneuver with timely, accurate, and responsive fire support. Because fire support is critical to success, the field artillery of friendly forces will be the target of intensive threat counterfire, tactical airstrikes, and ground attacks. To provide the required fire support, we must be able to survive in this lethal environment. Survival of the battery will be accomplished only if the unit is properly trained to react automatically—with speed and immediate action—when under attack by hostile systems. We can survive to accomplish the mission only if we *train as we intend to fight*.

7-2. Responsibilities

a. The basic considerations of defense apply in all situations (see para 7-3). Planning, preparing, rehearsing, and position-hardening are the key elements of defensive operations in the battery area. General planning, coordination, and control are the responsibility of the battery commander. The first sergeant manages the defense program by preparing, rehearsing, and directing execution of the final plan.

b. When formulating the specific plan, the 1SG considers the potential enemy threat, the unit personnel status, and the time and materials available to determine the type and extent of defensive positions to be prepared. He determines the final location for crew-served and antitank weapons, defines fields of fire, locates observation and listening

posts, and recommends supplementary cannon positions for defense of the battery.

c. The first sergeant coordinates closely with the XO in selecting targets and sectors for the employment of the cannons in defense of the battery. The employment of HE shell with PD fuze on point targets, "Killer Junior" techniques (shell HE, fuze time fired at the lowest possible charge), smoke, "Beehive," and ICM for 6,400-mil coverage of the battery should all be considered. After coordinating the targets for the cannons, the XO determines individual firing data for each section and provides this data to the FDC and to each section. The employment of the cannons in defense of the battery is shown on the defense diagram.

d. The 1SG must also insure that the communications required to support the plan are installed, checked, and functioning properly. After he develops the battery defense plan, the 1SG should have the plan checked by the battery commander at the first opportunity. However, preparation of the position should not be delayed until the battery commander's approval is received.

e. Once position preparation has begun, the first sergeant supervises continuous improvement of the positions and reinforcement of the defense plan. He also insures that the small-arms and crew-served weapons ammunition resupply SOP is fully understood and complied with by all. The priority of tasks for position area improvement will depend to a great extent upon guidance received by the battery commander concerning the current threat.

Section II. ORGANIZATION OF THE DEFENSE

7-3. Basic Considerations

In planning and preparing the defense plan,

the battery leaders must keep in mind the nine basic considerations of defense.

a. Analyze and use terrain properly. Selecting a battery position where the fire support mission can be accomplished is the least difficult task. This means that the challenge is in selecting a position that is not easily detected or attacked, is easily defended, and allows mission accomplishment.

b. Plan to defend in depth. A defense in depth conserves battery assets and provides time to mass forces at the point of attack.

c. Establish and maintain security. The enemy achieves surprise and can get the upper hand if the battery cannot respond to an attack rapidly. Good security prevents surprise attacks. Close coordination with maneuver units helps to achieve and maintain security.

d. Plan to defend in all directions. Normally, the enemy can attack from any direction, so the battery must be able to defend in all directions. Plan to use preselected positions within and outside the battery area.

e. Plan mutual support. Mutual support is one unit helping another unit or one soldier helping another soldier. Fires from other batteries should be coordinated for defensive fires and attack of long-range targets. Within the battery, one section must be ready to support another section. Apply the same concept to the individual soldier, and you can build a formidable defense. Range cards for crew-served weapons and howitzers are essential to a good defense.

f. Practice dispersion. Separate personnel, fighting positions, cannon sections, and other battery elements so that a single attack will not neutralize all or a major part of the battery.

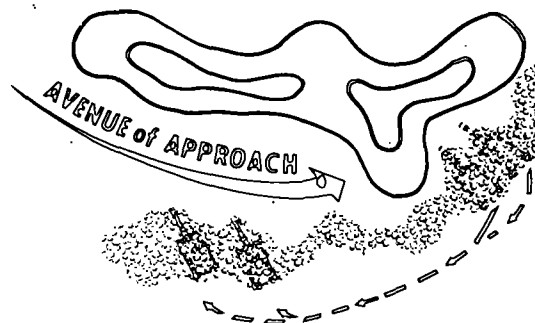
g. Establish control. The battery commander must control his personnel and firepower before, during, and after an attack. This is so the correct actions can be taken at the right time. Develop battery SOPs so that everybody will know what to do.

h. Establish priorities. Establish critical defensive tasks and put them in priority based on the anticipated threat.

i. Be flexible. No fight will ever go exactly as planned, and the commander must respond quickly to the unexpected. He must constantly evaluate his mission, the enemy, troops and weapons available, terrain and weather, and be prepared to deal with situations that are not in the "plan."

7-4. Use of Terrain

The defense plan must take maximum advantage of available terrain. Here are some fundamental terrain considerations.



a. Avenues of approach must be covered by fire. Air avenues of approach will probably be along the linear axis of the battery or down the natural lines formed by valleys or ridgelines. Consideration should be given to positioning air defense resources, to include Redeye, on the flanks of the battery or at the entrances to a valley. Each FA cannon battalion is authorized one Redeye section, consisting of three or more Redeye teams. A team consisting of two personnel, a ¼-ton vehicle with radio, and Redeye weapons is normally attached to each cannon battery. In addition to providing early warning of and defense against air attack, the Redeye team can also be used as one of the battery observation posts to provide early warning of a ground attack. Fields of fire are necessary to cover ground avenues of approach into a position area in order to destroy the enemy and break up his assault.

b. Good observation provides information and aids in early warning. It denies the enemy the element of surprise and should be coordinated within the unit and between adjacent units when possible.

c. *Obstacles* are used to delay, stop, divert, or canalize an attack force. Time and material available will dictate the degree of construction of manmade obstacles. Maximum advantage must be taken of natural obstacles. Types of manmade obstacles and techniques for their employment are found in FM 5-15.

d. *Cover* provides protection from the effect of weapons fire. Both natural and manmade objects can be used. Since time will not usually permit elaborate position-hardening, take maximum advantage of natural cover. In fast-moving situations, or when emergency displacement may be anticipated, hardening might be limited to digging foxholes on the perimeter, burying wire, placing sandbags around sensitive equipment such as collimators and tires, and constructing individual shelters for prone personnel.

(1) If natural cover is limited or unavailable, infantry fighting positions should be constructed. See FM 7-7 for further information.

(2) Although assets are very scarce, engineer equipment can be helpful in hardening the SP position. An experienced dozer operator can provide a suitable position, either dug in or bermed up. Such a position should be long enough to permit the M548 ammunition vehicle to occupy the same position, as shown. However, the commander must exercise caution when hardening a position in this manner. The dirt spoil and

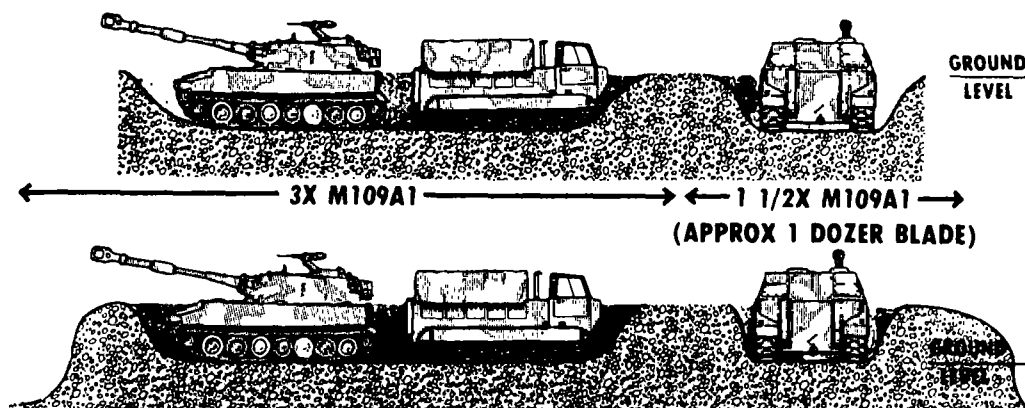
dozer tracks must not be allowed to destroy the camouflage effort. FM 5-15 contains good examples for hardening the towed weapon position.

7-5. Defense in Depth

Defensive operations should be planned so that the battery commander will be warned of an impending attack in sufficient time to displace his unit or to defend the position. In either case, the defense must protect the unit against air, ground, and artillery attack from all directions. When establishing a perimeter defense, it is critical to coordinate with adjacent units to provide mutual support and to preclude firing into a friendly position. The defense can best be described as having three elements.

a. The *long-range element* provides observation along likely avenues of approach and advance warning for the BC to implement his defensive plan. This portion of the defense involves the use of observation posts and intelligence reports.

b. *Supplementary positions* are the positions from which the unit can accomplish a mission that cannot be accomplished from the primary position, or from which it can defeat or stop the enemy outside the battery perimeter. Weapons that can be employed at these positions include the LAW with machinegun support and, in some instances, a cannon platoon or the 50-caliber MG on the M548 ammunition carrier. The machinegun can be ground-mounted to increase the



firepower and security of the supplementary positions. Support of the supplementary positions could consist of such items as planned indirect fires and natural and manmade obstacles.

c. For *perimeter defense*, the close-in defense plan is prepared by the first sergeant and is designed to protect against ground attack. During the hours of darkness, early warning devices must be so positioned as to give a reaction force enough time to deploy.

7-6. Establishing and Maintaining Security

The cannon battery is highly vulnerable to attack as it occupies a new position. The first order of business is establishing security. Initially, this consists of establishing observation and listening posts. The security system can be expanded and strengthened as time permits. Techniques and methods for providing security are:

a. *Intelligence channels*. Higher headquarters and adjacent units can provide information about enemy activities that threaten the cannon battery. In addition, FISTs, fire support officers, and information gathered from the battalion command/fire direction net can provide warning of impending attack. Only direct support battalions have this direct link with maneuver forces. DS battalion staffs must be trained to aggressively pass on enemy information through FA communications channels to reinforcing and GSR battalions and to the force artillery headquarters.

b. *Observation and listening posts*. These must be positioned a sufficient distance from the battery to provide early warning and time to react to the threat. The distance depends on visibility, the mobility of the enemy, and the extent to which the terrain conceals the position from direct fire weapons. Observation posts (OP) and listening posts (LP) must cover avenues of approach. Several may be required to provide full coverage. Listening posts augment observation posts when visibility is reduced and fill gaps when OPs are withdrawn at night. LPs and OPs should be withdrawn when enemy contact is imminent. When possible, each OP and LP

should be manned by at least two men. Each location should have both a primary and alternate means of communication.

c. *Early warning devices*. Used best to supplement LPs and OPs, these devices can range from rocks in tin cans and trip flares to sophisticated electronic anti-intrusion devices. Unattended ground sensors should be placed forward of OPs and LPs, particularly in areas not visible from the posts. Types of unattended ground sensors and techniques for their employment are found in FM 31-100.

7-7. Camouflage

a. "If it can be seen, it can be hit. If it can be hit, it can be killed." A battery that is concealed or cannot be recognized has greatly increased odds for survival. The following principles of concealment lead to better camouflage.

(1) *Siting*. All terrain has a distinguishable pattern, either natural or manmade. The positions for equipment and personnel that will be camouflaged should be selected with an eye toward blending camouflage materials with the natural pattern.

(2) *Camouflage construction*. Use of natural and or manmade material will extend the natural pattern of the area over and around equipment, personnel, and areas of activity. Vegetation can be used effectively for this purpose, but—

(a) Natural vegetation should be cut from the areas away from the battery position. Freshly cut stumps and limbs encircling the battery area draw attention to the area. Mud can be used to conceal fresh cuts.

(b) Pine limbs do not grow in oak thickets. The vegetation must *match* what is naturally in the battery area.

(c) Cut vegetation must be replaced as often as practicable.

(d) Vehicles and equipment should be pattern-painted. TC 5-200 is useful in this area.

(e) Camouflage nets are excellent if used properly. A howitzer in an open field

under a camouflage net is easily seen (though it may not be readily identifiable). That same howitzer between two trees and under a camouflage net will probably not be seen.

(f) Remember the natural pattern and blend with it. In urban areas, equipment should be in buildings or at least in the shade of buildings. Camouflage nets may not blend with buildings, but canvas stretched over a frame will.

(3) *Camouflage discipline.* The appearance of the area should not be changed. Each individual in the battery must be careful not to disclose the presence of military activity. Noise and light discipline are two of the more common problem areas. They both are particularly important at night. Noise draws attention and can be identified. Light leaking from a tent is a target for direct fire weapons.

b. The most common signs of military activity in an otherwise well camouflaged area are tracks, spoil, debris, and movement. The BC must enforce his track plan. Existing roads and trails must be used. If none are available, some should be created with heavy vehicles to give the appearance that a unit has moved *through* the area (the roads and trails must have logical starting and terminating points). Spoil from position hardening must be camouflaged. Debris from expended ammunition and the mess area must be policed up and camouflaged. Shine from headlights, windshields, mirrors, and mess equipment can easily be eliminated with scrap canvas, sandbags, and paint, as appropriate. Even the signature of smoke generated by the mess section's stoves can be reduced by restricting use to periods between dusk and dawn.

c. Supervisors should read FM 5-20 for more information.

7-8. Deception

No matter how well the battery is camouflaged, the signature of firing cannot be disguised. The object of deception is to make the enemy direct his counterfire efforts to the wrong area.

a. One technique is to establish *dummy positions*, but permission must be obtained

from higher headquarters first. (Dummy positions should be established only in areas where counterfire will not cause friendly casualties.) Techniques used to establish a good dummy position are:

(1) Establish obvious vehicle tracks leading into the dummy position.

(2) Use logs, dead trees, or stove pipe sections to simulate cannon tubes.

(3) Place soil around the position as if a fighting position has been prepared.

(4) Make crude attempts to camouflage the position.

(5) Place discarded equipment and trash around the dummy position.

(6) Regularly conduct radio transmissions from or near the dummy position area.

(7) Use the position as an offset registration position or as a roving gun position.

b. Use of the *roving gun* is another deceptive technique. The roving gun is one weapon of the battery operating away from the battery area. The roving gun moves frequently, since its location will likely be compromised once it has fired a mission. The purpose of using a roving gun is to reduce the amount of fire from the battery position in order to avoid disclosing the position to the enemy target acquisition means. It may also cause the enemy to direct its counterfire to the dummy position. Some considerations in employing the roving gun are:

(1) Fire direction and command and control capability must move with the roving gun.

(2) The number of missions fired from the same position will be limited.

(3) The roving gun must be positioned so that counterfire does not hit other friendly forces.

(4) An unacceptable reduction in firepower may be caused by pulling one weapon out of the normal firing position.

7-9. The Defense Diagram

Upon occupying a position, each section must

have a predetermined sector of responsibility that makes maximum use of the section's primary weapon(s). As soon as practical, the BC should evaluate the defensive plan by studying the defense diagram. The defense diagram is a sketch, drawn to scale, of the battery defensive resources. It is based on the data from each howitzer and machinegun range card, and includes the fields of fire for other weapons such as grenade launchers, antitank weapons, and individual weapons. The diagram is prepared by the 1SG and approved by the battery commander. A copy is provided to the battalion CP.

a. Equipment required. To construct the defense diagram, use a 1:50,000 map of the area, a coordinate scale, a protractor, overlay paper, and a blank 1:25,000 grid sheet.

b. Construction of the matrix.

(1) Locate the battery center on the 1:50,000 map. Identify the grid square or squares that contain the terrain features that influence the defense of the battery position.

(2) Place tick marks at 200-meter intervals along the sides of the selected grid squares (fig 7-1).

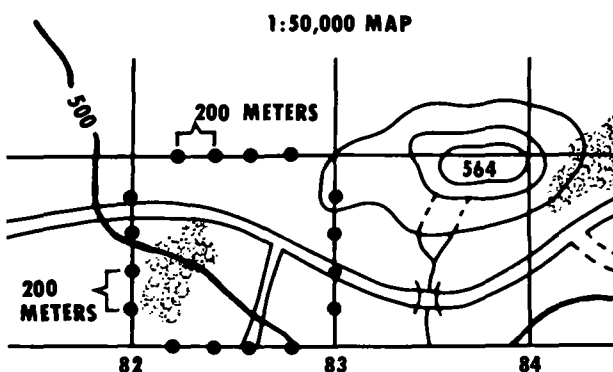


Figure 7-1. Tick-marking grid square.

(3) Connect the tick marks to form 200-by-200-meter squares within each grid square (fig 7-2).

(4) Label the squares beginning at the lower left of the grid square. Number the lines

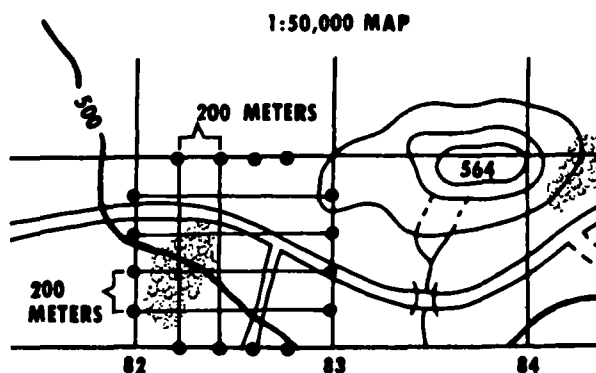


Figure 7-2. Forming the matrix.

to the right and up, as you would read a map (fig 7-3).

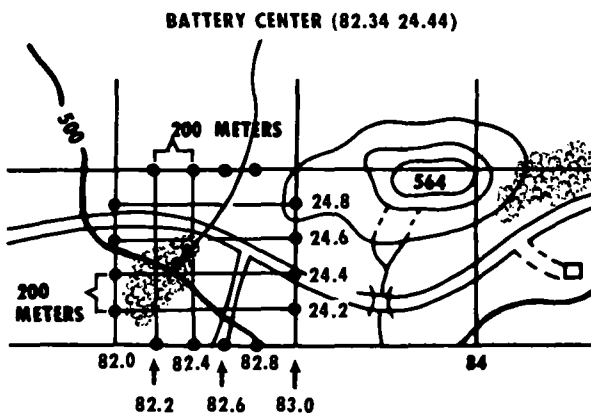


Figure 7-3. Labeling the matrix.

(5) Expand the scale to 1:5,000 by using a blank 1:25,000 grid sheet. In expanding the scale to 1:5,000, each 200-by-200-meter block within the matrix correlates with a 1,000-meter grid square on the 1:25,000 grid sheet. Determine which 200-by-200-meter block on the matrix contains the battery center. In figure 7-3, it is 82.2 24.4. Next, select a square near the center of the blank grid sheet, and label this square the same—82.2 24.4. You have identified and labeled the 200-by-200-meter block where the battery center is

located. From this point, duplicate the labeling from the matrix on the grid sheet.

(6) Reproduce key terrain. Examine the 200-by-200-meter blocks on the 1:50,000 map that contain key terrain features that influence the defense. Sketch what you visualize in these blocks on the corresponding squares of the 1:5,000-scale grid sheet. The result will be a map reproduction minus the contour lines and other data not pertinent to the defense of the battery. However, contour lines representing hills or depressions may be included if they are deemed pertinent (fig 7-4).

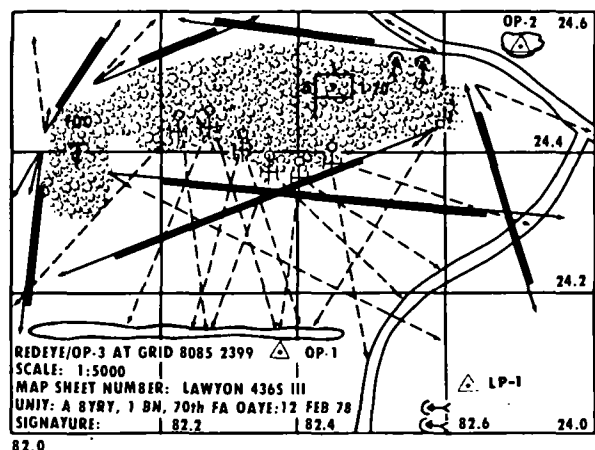


Figure 7-4. Completed defense diagram.

c. Plotting on the diagram. Use the coordinate scale to plot coordinates and to measure distance on the 1:5,000 scale grid sheet by dividing the indicated graduations on the coordinate scale by 10; e.g., the 1,000-meter graduation is read as 100 meters. Use the protractor for measuring azimuths or direction.

(1) Using the coordinate scale, plot the battery center on the 1:5,000 scale grid sheet. Construct a light line indicating the azimuth of fire. Next, draw a light line perpendicular to the azimuth of fire. Insure that this line crosses battery center. These two lines are used for orientation in direction; i.e., right,

left, forward, and rear of the battery center. (Once you have completed the diagram, you may erase these lines.)

(2) Plot the weapon locations and sectors of fire. The following sources are available to assist in this task:

(a) Machinegun range cards indicate the location (distance and direction from battery center or other know point) and the azimuths of the left and right limits and/or final protective line (FPL). The range card is prepared for all crew-served weapons. It is a record of firing data necessary to engage preselected targets within the sectors of fire during periods of limited visibility. The range card may also be used as a reference to engage targets and to aid in the preparation of the defense diagram. Details on preparing machinegun range cards are in FM 23-67.

(b) Cannon range cards indicate deflections of the left and right limits. In addition, they should show key terrain features as well as predesignated targets with firing data. The range card should consist of two parts—a sketch of the sector(s) of fire containing targets and reference points and a data section that lists data necessary for engaging targets during periods of limited visibility. The format shown in figure 7-5 is recommended for the range card.

(c) Locations of howitzers with respect to battery center must be computed by the FDC, based on deflections and distances from the aiming circle. Other weapons, mines, obstacles, OPs, LPs, and other key installations are located by direction and distance from a known point; e.g., battery center, a howitzer, or a terrain feature.

(3) In all cases, locations should be plotted within 10 meters and directions within 10 mils. On the diagram, the actual location of a weapon is indicated by the base of the stem of the weapon symbol. See FM 21-30 for symbols.

7-10. Defense SOP

A battery is highly vulnerable to enemy action as it first enters a new position. Elements of the battery may still be on the road, and the defense plan for the position

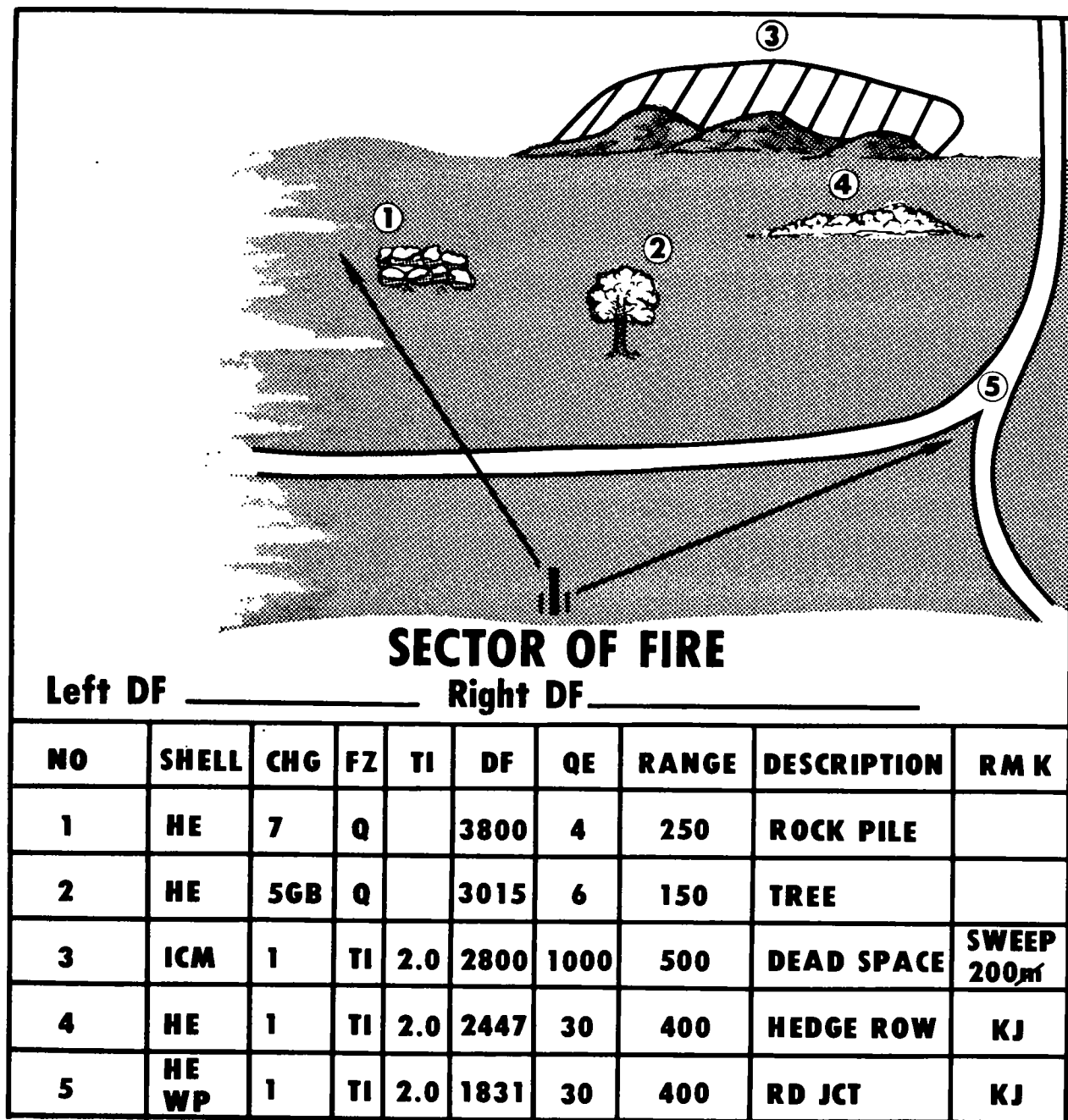


Figure 7-5. Howitzer range card.

Note. After laying and establishing aiming points, determine the left and right deflection limits and the deflection to key features or targets on the howitzer range card following these steps.

1. Set the azimuth scale to 3200.
2. Traverse until the line of site of the pantel is on the point selected.
3. Turn the azimuth knob until a correct sight picture is obtained on the collimator/aiming posts.
4. Record the deflection now shown on the reset counter scale (M100-series sight), or the azimuth scale (M12-series sight) as appropriate.

may not yet have been implemented. Each battery must prepare an SOP that tells each section its area of responsibility around the battery until the defense plan is implemented. The SOP and the defense plan *must* cover the following areas:

a. Priority of tasks for position area improvement, based upon whether the BC anticipates remaining during hostile indirect fire or conducting an emergency displacement.

b. An alert signal for emergency displacement triggered by hostile indirect fire.

c. An easily identifiable rally point far enough from the battery position to escape counterfire directed against the battery, and provisions for guides to remain at the rally point to pick up soldiers who become separated from the battery.

d. Provisions for each machinegun, air defense weapon, and antitank weapon to be supported by rifle fire.

e. At all OPs/LPs with crew-served weapons, establishment of sectors of fire and placement of stakes to indicate sector limits.

f. Scheduled reports to be made by personnel at all OPs and LPs.

g. Establishment of unmistakable warning signals.

h. At dawn and at dusk, small patrols to conduct local security patrols of the terrain immediately surrounding the battery, paying particular attention to the main supply route and avenues of approach to the position area.

i. A standardized resupply plan for small-arms ammunition and grenades.

j. Rehearsal of NBC attack detection and alarm procedures and signals.

k. At night or under limited visibility, particular attention paid to the following:

(1) Use of signs and countersigns.

(2) Noise discipline.

(3) Limited movement within the battery area.

(4) Light discipline.

(5) Employment of available night observation devices.

(6) Use of illumination if required.

(7) Restriction of entrance and exit points on the perimeter.

7-11. The Field Storage Location (FSL)

In nuclear-capable units, the following considerations pertaining to the FSL should be applied during field training and be included in the defense SOP.

a. There should be a plan to evacuate nuclear weapons if the battery area is threatened.

b. Command disablement or emergency destruction (ED) of nuclear weapons may be required to prevent the capture or use of US weapons by the enemy, or the compromise of design information. Disablement or destruction is mandatory when:

(1) A combat unit or position is about to be overrun.

(2) A combat unit is unable to evacuate a part or all of its weapons during a withdrawal.

c. Unit SOP must provide for ED of the unit's nuclear weapons. The unit's normal ED capability (i.e., ED materials, personnel designated, time allotted for execution) will be of sufficient level to insure emergency destruction of all unit weapons. The SOP will specify:

(1) The amount of ED material to be on hand at all times.

(2) How and where ED material will be carried during movement.

(3) How and where ED material will be stored with reference to the FSL.

(4) Who in the unit is authorized to order ED and how the order will be disseminated.

(5) Which unit personnel will execute the ED.

(6) How execution of ED will be coordinated with other emergency operations

(e.g., local defense, withdrawal, evacuation, and destruction of other classified or major items of equipment).

d. By its nature, emergency destruction will take place during a period of great stress and confusion. Commanders must insure that sufficient personnel, trained and designated to execute ED, will be available and will not be so committed to perimeter defense or to some other activity that they cannot disengage to execute ED on order. Selected personnel will also be trained in

secondary methods of destruction.

e. Emergency destruction may be directed by higher headquarters, or it may be executed at the discretion of the immediate commander or the senior survivor, based on the situation.

f. Command disablement should be considered when time does not permit a unit to destroy weapons in accordance with established ED procedures. Unit SOP will provide for command disablement in accordance with theater guidelines.

Section III. CONDUCT OF THE DEFENSE

7-12. Defense Against Armor

a. If FA cannons must be employed against enemy armor, at least a platoon should be deployed. This platoon should engage the tanks from supplementary positions outside the battery area, using the maximum charge available. "Kill zones" should be designated at distance to permit proper functioning of fuzes. Weapons should be fired in sequence. A howitzer should be used in a direct fire role against armor only in extreme circumstances!

b. Tank-killer teams are small groups of personnel (usually four to six) drawn from sections of the battery and especially trained in the use of antitank weapons, mines, and field expedients. They must be trained in the capabilities and identification of enemy armor, method of engagement, and techniques for destruction of armor. The teams are deployed solely in a defensive role and add a physical and psychological advantage to the battery antiarmor capability. Antiarmor weapons positions and kill zones should—

(1) Be outside the battery area to prevent the armor from firing directly into the battery area.

(2) Have a primary position and a series of alternate positions. Because of the backblast signature of the LAW, only one round should be fired from each position, since the tank will probably return fire with its main gun. A covered and concealed

entrance/exit route to each position increases the survivability of the operator.

(3) Allow 90° flanking fires on armor avenues of approach, since the sides and rear of a tank are the most vulnerable.

(4) Allow antiarmor weapons to be deployed in pairs as a minimum. This deployment allows continuous engagement through alternating firing and mutual support among antiarmor weapons. Firing in pairs and in sequence also greatly improves the probability of killing a tank.

(5) Be designated within the maximum effective range of the weapon (LAW-200 meters). If time permits, range cards similar to the cannon range card may be prepared for each position.

7-13. Response to Hostile Indirect Fire

a. The threat of receiving indirect fire is at least as great as the threat of air or ground attack. Enemy forces plan to attack our artillery with great volumes of ammunition. When this occurs, two responses are possible—displace to an alternate position or remain in position and continue the mission in place even under fire.

b. The key to countering the hostile indirect fire threat is effective training for survival. Every means available to reduce vulnerability and increase survivability must be fully explored and used. Cannoneers must understand, as second nature, the

immediate actions they are required to perform when fired upon.

c. Upon reaching its firing position, each battery accomplishes a number of minimum tasks. These tasks have been grouped under the memory aid TLASBAPP:

- T** — Trails, spade or firing platform emplacement
- L** — Lay the weapon
- A** — Aiming points
- S** — Site to crest
- B** — Boresight
- A** — Azimuth markers
- P** — Prefire checks
- (P)** — Position area improvement

This format provides common goals for actions and reactions among battery personnel—specifically, section chiefs and cannoneers. Other tasks representing the last (P)—position area improvement—are completed as time permits, in an effort to continually harden the position. Just as there are priorities in preparing the weapons to fire, there must be priorities for improving the position area to insure the battery is best able to react to indirect fire.

d. Tasks such as camouflage, digging-in, and alternate position preparation must be given priorities by the BC. He must consider all factors, to include the mission, his commander's guidance, and the enemy situation. The assignment of priorities by the BC provides guidance to the section chiefs, who, in turn, establish priorities for the cannoneers in their sections.

e. Whether a battery anticipates rapid emergency displacement or expects to remain in position when "hit" by incoming fire, it must still accomplish the full range of position area improvement tasks. The key difference is determining which to do first.

(1) A battery required to continue the mission under indirect fire will harden its position before it improves an alternate position.

(2) A battery given permission to displace upon receipt of indirect fire places its priority of effort on preparing alternate positions, designating displacement routes,

and establishing a signal to march order before it devotes time to hardening tasks.

f. The commander instructed to continue his mission in the position despite hostile counterfire might establish these prioritized tasks:

- (1) Camouflage position area.
- (2) Harden critical items of equipment.
- (3) Prepare individual foxholes.
- (4) Prepare defensive positions.
- (5) Select alternate position(s), displacement route(s), and signal should movement be unavoidable. Brief key personnel.

(Counterfire received)

- (6) Personnel take cover; mask/vest as necessary.
- (7) SITREP to battalion.
- (8) Recover unsecured/unprotected items.
- (9) Conduct crater analysis and submit SHELREP.

Based on these, his section chiefs would, in turn, designate their priorities. There are many techniques a section chief could use to assist him in his effort. One method might be to make a simple matrix which outlines the key duties of crewmembers during an attack. Table 7-1 shows an example of this approach.

g. As mentioned earlier, the unit's mission governs the priority of tasks. The battery commander told to displace upon receiving fire has a different list in mind. For example:

- (1) Camouflage position area.
- (2) Prepare limited protection for personnel/equipment.
- (3) Recon/select alternate position(s), displacement route(s), and march order signal.
- (4) Prepare alternate position(s).
- (5) Prepare defensive positions.
- (6) Improve individual protection.

Table 7-1. Example Duty Assignment Matrix (Unit to Maintain Present Position)

Section Chief	Gunner	Assistant Gunner	Section Members	Driver
1. Prepare range card.	Sandbag the collimator.	Install camouflage net.	Harden critical items of equipment with sandbags (M548, all tires, etc.)	Bury the wire.
2. Brief personnel on displacement route(s), alternate position, and signals to be used.	Assist with camouflage.	Continue to improve camouflage, i.e., use natural vegetation.	Prepare individual and defensive positions.	Become familiar with displacement route(s) and alternate position.
3. Supervise at supplementary position, assign members to crater analysis team.	Continue to improve camouflage.	Prepare supplementary position.	Selected members prepare supplementary positions.	Assist at supplementary position.
4. Take cover, mask/vest, and man defensive positions as necessary.				
5. Continue the mission.				

Table 7-2. Example Duty Assignment Matrix (Unit Allowed to Displace)

Section Chief	Gunner	Assistant Gunner	Section Members	Driver
1. Prepare range card.	Sandbag collimator.	Install camouflage net and improve with vegetation.	Assist with camouflage.	Prepare vehicle for quick evacuation.
2. Brief personnel on displacement route(s), alternate position, and signals to be used.	Supervise preparation of alternate position.	Continue improvement of camouflage.	Selected members continue camouflage. Selected members prepare alternate positions.	Become familiar with displacement route(s) and alternate position. Assist at alternate position.
3. Supervise preparation of individual and defensive positions.	Supervise improvement of equipment protection.	Assist at individual and defensive positions.	Selected members prepare individual and defensive positions. Selected members improve equipment protection.	Assist with equipment protection.
4. Take cover, mask/vest as necessary.				
5. Continue mission while awaiting signal to displace.				
6. Displace as per prior instructions.				

(7) Improve equipment protection.

(Counterfire received)

(8) Signal march order (emergency displacement).

(9) Displace to alternate position.

(10) Report displacement.

(11) Continue mission from alternate position.

The section chief's subsequent priorities are illustrated in table 7-2.

7-14. Other Attacks

a. Ground attack. Personnel will man predesignated defensive positions on the perimeter. Machineguns are located to provide final protective fires. Howitzers are prepared to engage targets in predesignated sectors of fire established and coordinated with the battalion FDC for mutual support of other firing batteries. In addition, a reaction force is established. This force is made from various sections of the battery. This will insure that no one section is reduced to the point that it is incapable of performing its primary mission or covering its section of the perimeter. An alert signal and assembly area must be designated. This alert force is designed to—

(1) Reinforce the perimeter as needed.

(2) Stop or destroy small groups penetrating the perimeter. The area of responsibility for the reaction force should be within the perimeter and they must be thoroughly briefed before committed. When one reaction force is committed, an alternate force should be assembled. Reaction forces must be well rehearsed to insure speed and teamwork.

b. Air attack. Air defense weapon systems are manned. Personnel disperse, take cover, and return fire with small arms and automatic weapons. Weapons should be fired straight up to form a wall of bullets through which the aircraft must fly. The important thing is that *everybody* shoots!

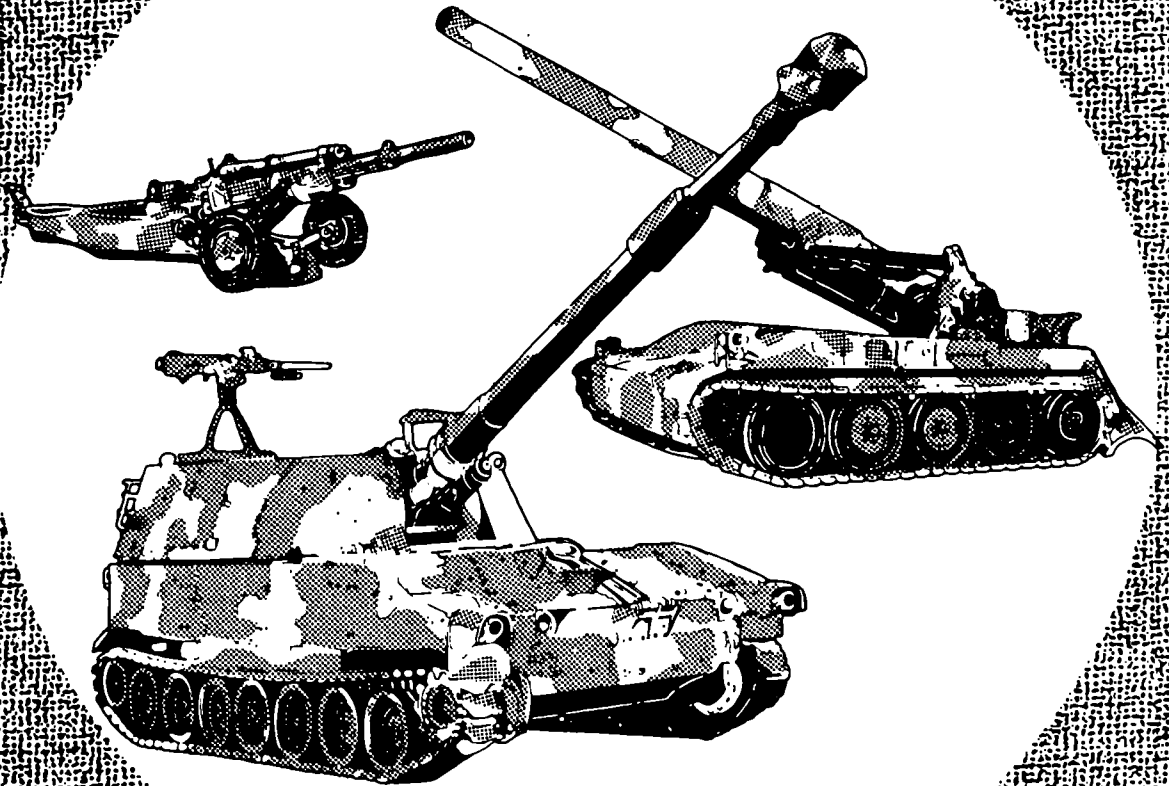
c. Nuclear and chemical attack. For appropriate discussion of defensive measures, see FM 21-40 and FM 21-41. Refer to STANAG 2047 (appendix H) before developing standard warning signals for chemical or nuclear attack.

For a more detailed approach to defense in the battery area, see TC 6-20-9, *Field Artillery Cannon Battery Defense*, which is written to complement this chapter. Techniques that become validated and refined through field exercises will be incorporated into FM 6-50.



PART THREE

OPERATIONS



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CHAPTER 8

LAYING THE BATTERY

Section I. THE AIMING CIRCLE

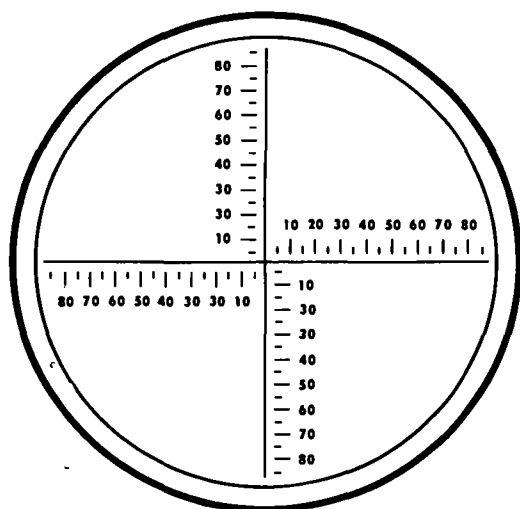
8-1. General

The M2 aiming circle is the cannon battery's primary means of orienting, or laying, its weapons on the azimuth of fire. It is a solid, reliable instrument, but it must be cared for and operated correctly. It is important that each person involved with using the aiming circle be thoroughly familiar with how to operate and maintain it. This chapter presents information that should be the starting point for any aiming circle training program.

8-2. Components

The instrument operator must be thoroughly familiar with the components of the aiming circle. The following is a discussion of the major components.

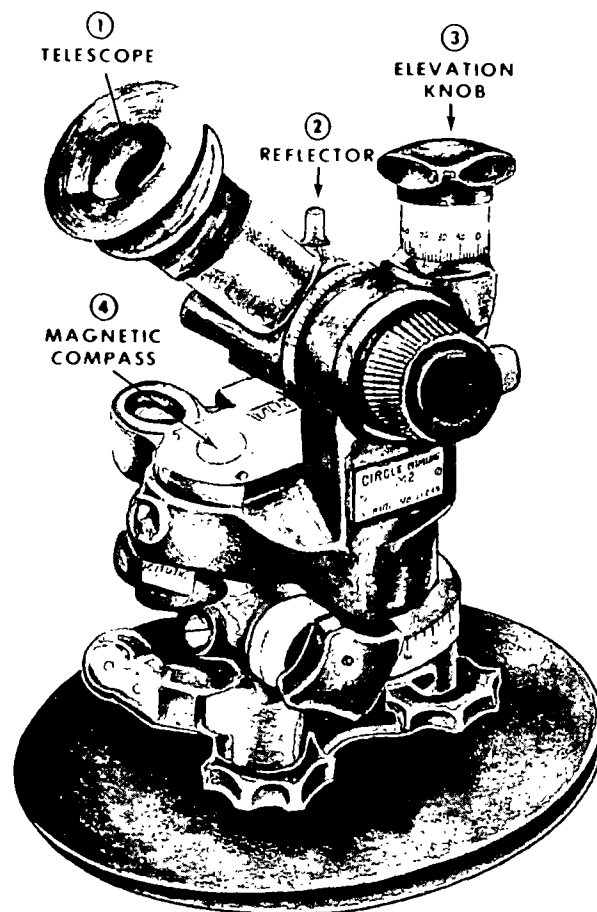
a. Telescope. The telescope (1) is a 4-power, fixed-focus optical instrument with a reticle pattern like this—



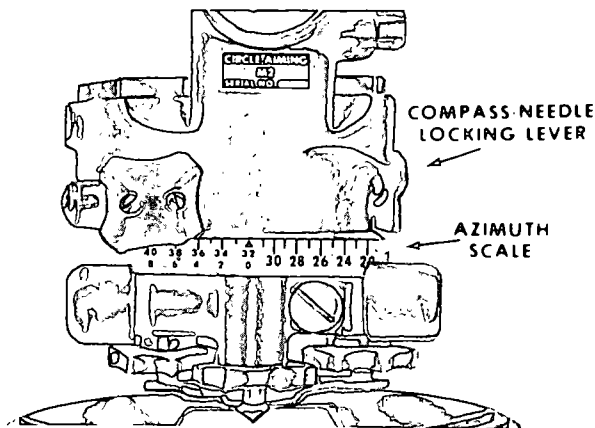
b. Reflector. The reflector (2) is a plastic signal post mounted on top of the telescope and is used as an aiming point for other instruments sighting on the aiming circle.

c. Elevation knob. The elevation knob (3) is used to raise and lower the telescope in order to sight on the sight of a weapon or some other aiming point. The elevation scales are not used during laying and measuring.

d. Magnetic compass. The magnetic compass (4) is located in the oblong recess in the top of the body assembly. For rough centering, the magnetic needle may be seen through the windows on top of the body assembly. A small glass magnifier (5) and reticle with three vertical lines are at one end of the recess to aid in aligning the end of the magnetic needle. When the locking lever is in



a vertical position, the needle is locked. When the lever is turned either right or left to the horizontal position, the needle is unlocked. To preclude damage to the magnetic needle, this lever should be returned to the locked position gently. The needle should be locked when it is not in use!



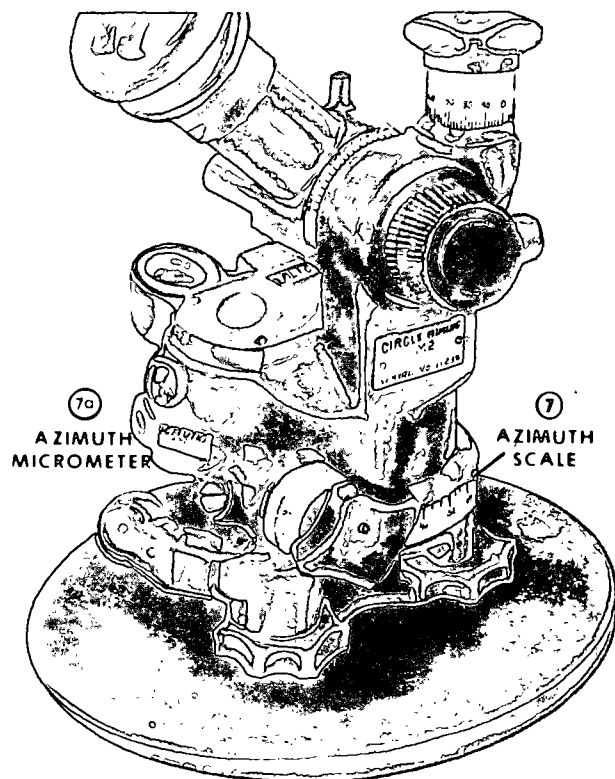
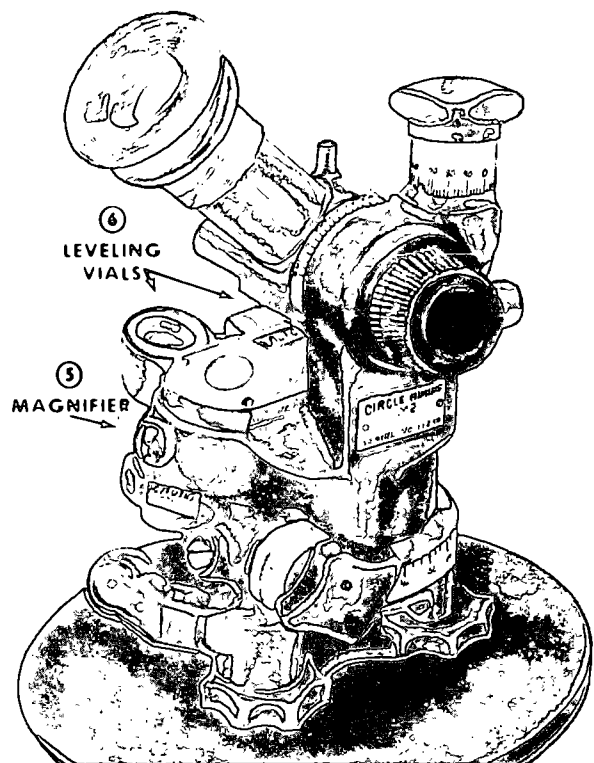
e. Leveling vials. There are two tubular leveling vials and one circular leveling vial (6) on the aiming circle. One tubular leveling vial is used in leveling the telescope so that the operator can measure vertical angles. The other tubular leveling vial is used in leveling the aiming circle for measurement of horizontal angles. The circular leveling vial (fisheye bubble) may be used by the firing battery in an emergency. When the tubular leveling vials are not in use, the protective covers should be closed to prevent damage.

f. Azimuth scale and azimuth micrometer.

(1) The azimuth scale (7) is located below the magnetic compass housing. It is graduated in 100-mil increments from 0 to 6400 mils and is numbered every 200 mils. The portion of the azimuth scale from 3200 mils through 6400 mils has a second 0-3200 scale (numbered in red from the black 32 through the large black 0 on the azimuth scale).

(2) The azimuth micrometer (7a) is located on the azimuth knob on the lower right side of the magnetic needle housing. It is graduated in 1-mil increments from 0 to 100 mils and is numbered every 10 mils.

g. Upper (recording) motion. The upper motion allows the operator to place



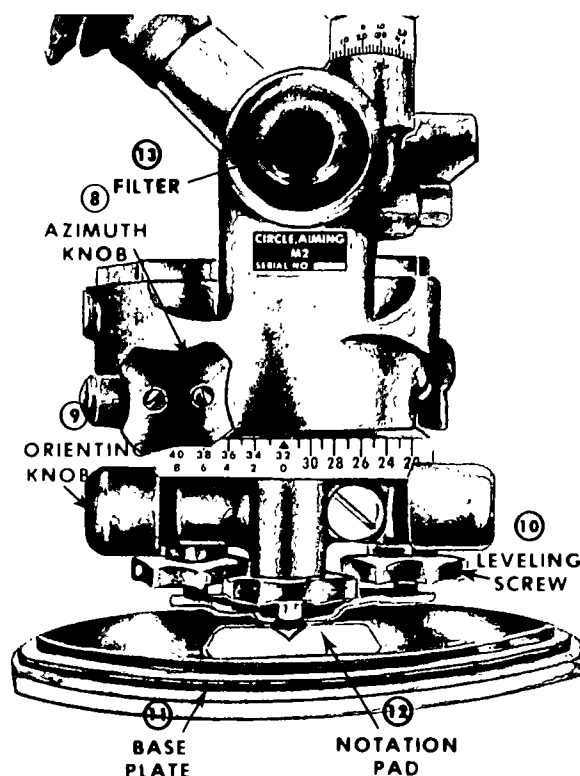
instrument readings on the azimuth scale and azimuth micrometer by means of the *azimuth knob* (8). The values are read on the azimuth scale index, which is located below the magnetic needle magnifier. The upper motion of the instrument has both a fast motion and a slow motion. Lateral movement of the azimuth knob produces fast motion. Rotation of the azimuth knob produces slow motion. Horizontal angles are read in two parts—the hundreds of mils are read from the azimuth scale and the tens and units of mils are read from the azimuth micrometer.

h. Lower (nonrecording) motion. The lower motion is controlled by the *orienting knobs* (9) and is used to orient the 0-3200 line of the aiming circle without changing the instrument reading. Lateral movement of one orienting knob produces fast movement of the lower motion of the aiming circle. The two orienting knobs should be used simultaneously for slow movement of the lower motion. Caps are provided for covering the orienting knobs to prevent unintentional use of the lower motion.

i. Leveling screws. The three leveling screws (10) are used to level the aiming circle. These screws are on a spring plate located below the orienting knobs and above the base plate assembly.

j. Base plate assembly. The base plate assembly (11) is the base of the instrument when it is mounted on the tripod and also serves as the base of the carrying case. It is a flat circular plate to which the instrument is attached by means of the spring plate. An instrument-fixing screw is threaded into a socket on the underside of the base plate assembly to attach the instrument to the tripod. The socket is kept clean and free of obstructions by a spring-loaded cover that remains closed when the instrument is not attached to the tripod. The base plate is fitted with a rubber gasket that forms a watertight seal when the cover is latched to the base plate.

k. Notation pad. A rectangular *notation pad* (12) on the base plate is used for recording the declination constant, date of declination, and the vertical angle correction.



l. Filter. A filter (13), which is placed over the eyepiece for protection against the sun's rays, is stored on the cover side of the telescope body, where it is held in place by a spring-loaded ball.

8-3. Setting Up The Aiming Circle

To set up the aiming circle—

a. Unstrap the legs of the tripod, loosen the leg clamp wing screws, and extend the legs to the desired length. Tighten the leg clamp wing screws.

b. Place the tripod over the point to be occupied. One tripod leg should be pointing in the approximate direction of sighting, and the leg with the night light mount should be to the operator's left. The head of the tripod should be at a height that will place the telescope at a height convenient for the operator.

c. Firmly embed the tripod legs. Make sure the tripod head is approximately level when the legs are embedded, then remove the tripod head cover.

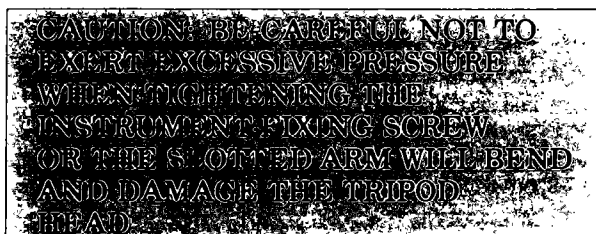
d. Pull back the spring plate on the base of the base plate and place the aiming circle on

the tripod. Loosely screw the instrument-fixing screw into the base plate.

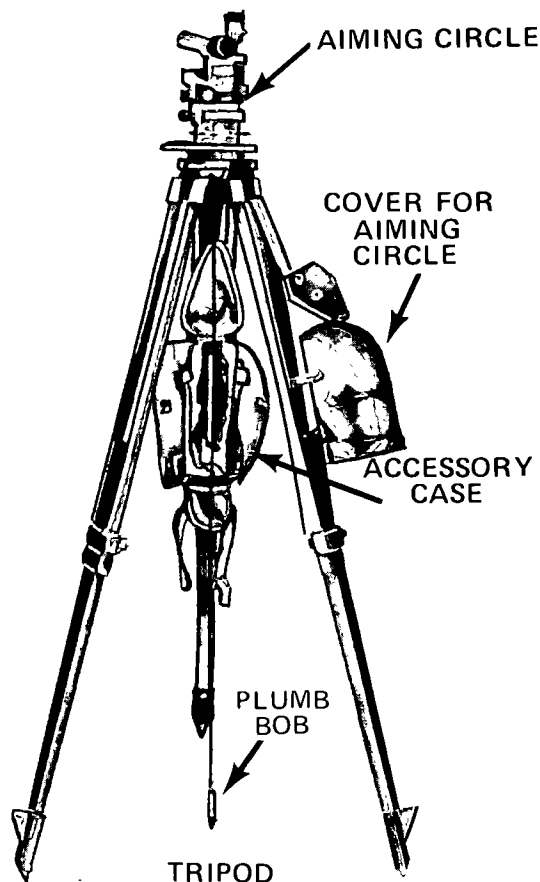
e. Attach the plumb bob to the hook under the instrument-fixing screw and center it over the orienting station by moving the base plate of the aiming circle. The plumb bob should be approximately 1 inch above the station marker.

f. Remove the aiming circle head cover, and hang it on the tripod head cover to prevent damage.

g. Screw the instrument-fixing screw into the base plate of the aiming circle.



h. Install the night lighting device accessory case if necessary. The aiming circle should now look like the one pictured here.



COMMON MALPRACTICES

Not clearing the area of magnetic attractions such as weapons, steel helmets, and eyeglasses.

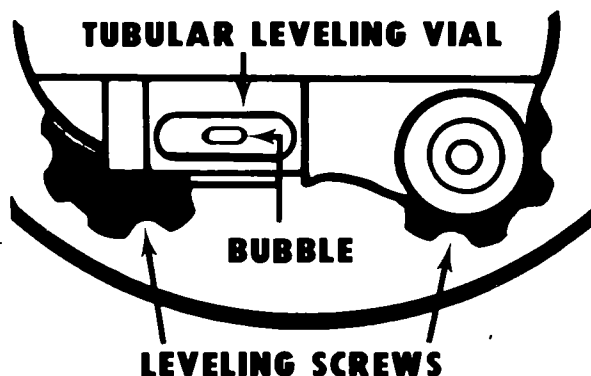
Failure to set up the tripod so that one leg points in the direction of the sighting. This puts one more tripod leg in the instrument operator's way as he moves around and increases the likelihood that he'll kick a leg and knock the aiming circle off level.

8-4. Leveling the Aiming Circle

To level the aiming circle for normal use—

a. Loosen the leveling screws to expose sufficient threads (three-eighths to one-half inch) on the three screws to permit the instrument to be leveled. Rotate the instrument until the axis of the *tubular* leveling vial is parallel to any two of the three leveling screws. Center the bubble by using these two leveling screws. Grasp the screws between the thumb and forefinger of each hand. Turn the screws simultaneously so that

your thumbs move either toward each other or away from each other at the same time. This movement tightens one screw as it loosens the other. The bubble always moves in the same direction as the left thumb.



b. Rotate the instrument 1600 mils and center the bubble by turning the third leveling screw.

c. Rotate the instrument back to the first position and relevel the bubble if necessary.

d. Repeat these steps until the bubble remains centered in both positions.

e. Rotate the instrument 3200 mils from the first position. If the bubble remains centered in this position, rotate the instrument 3200 mils from the second position. If the bubble remains centered in this position, rotate the instrument throughout 6400 mils. If the bubble remains centered, the instrument is level. If the bubble does not remain centered when the instrument is rotated 3200 mils from the first position, the leveling vial is out of adjustment. To compensate, using the same leveling screws that were used to place the instrument in the first position, move the bubble halfway back to the center of the leveling vial. Rotate the instrument 3200 mils from the second position and, using the other leveling screw, move the bubble halfway back to the center of the level vial. The instrument is now level, and the bubble should come to rest in its vial at the same off-center position (within one graduation) regardless of the direction in which the instrument is pointed. If the leveling vial is out of adjustment, the instrument should be turned in for repair at the first opportunity.

8-5. Hasty Leveling

In an emergency situation, when speed is of the essence, the following leveling technique may be used.

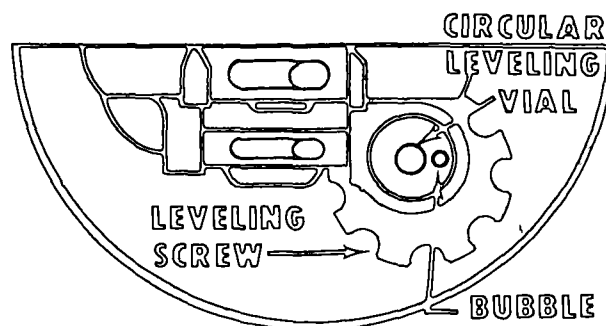
a. Loosen the leveling screws approximately halfway.

b. Rotate the head of the aiming circle until the circular leveling vial is over one of the three leveling screws at the bottom of the aiming circle.

c. Using the thumb and forefinger of each hand, turn the other two leveling screws in opposite directions. The bubble will move in the same direction as the left thumb.

d. When the bubble moves on line with the fisheye, center the bubble by using only the third leveling screw. Move the head over each of the other two screws. If more than half the bubble moves out of the center ring, relevel the instrument. If the bubble cannot be centered, use the technique discussed in

paragraph 8-4a, and turn the instrument in for repair as soon as possible.



8-6. Taking Down the Aiming Circle

To take down the aiming circle—

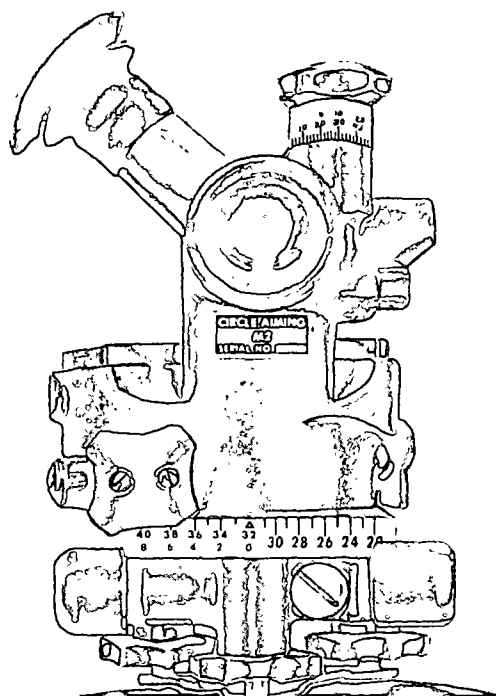
a. Tighten the leveling screws to their lower stops, then loosen each screw one-quarter turn.

b. **CHECK TO INSURE THAT THE MAGNETIC NEEDLE IS LOCKED.**

c. Cover the leveling vials.

d. Make sure that the caps of the orienting knobs are closed.

e. Place the azimuth knob over the notation pad. The aiming circle should now look like this—



f. Place the carrying case cover over the aiming circle and latch the cover locks.

g. Unscrew the instrument-fixing screw and remove the instrument from the tripod.

h. Replace the tripod head cover.

i. Retract and collapse the tripod legs and tighten the wing screws.

j. Strap the tripod legs together.

8-7. Declinating the Aiming Circle

a. To determine the declination constant for each instrument and to keep this declination constant current, certain rules have been prescribed outlining how often and under what circumstances the aiming circle should be declinated. The aiming circle must be declinated—

(1) After an electrical storm or any time the instrument has received a severe shock; e.g., if it is dropped from the bed of a truck to the ground. The magnetic needle is a delicately balanced mechanism, and any shock may cause a significant change in the declination constant for the instrument.

(2) Any time the aiming circle is moved 25 miles or more from the area in which it was last declinated. Because of local magnetic attractions, any move of the aiming circle may result in an appreciable change in the relationship of grid north and magnetic north as measured by the instrument.

(3) A minimum of once every 30 days to determine if any changes in the declination have occurred because of the annual shift of magnetic north or because of accidents involving the instrument that may not have been reported. If a radical change is observed, the instrument should be declinated again within a few days to determine if the observed change is a result of a magnetic storm or is a real change in the characteristics of the instrument.

(4) When it is initially received and any time it is returned from ordnance repair.

b. Variations in the declination constant at different times of the day are not significant enough to warrant declinating at any specific time.

c. There are certain factors that must be considered in determining the location at which an aiming circle is to be declinated.

(1) A declination station should be established at a place that is convenient to the using unit. It may be established by battalion or other higher headquarters, or by the target acquisition battery.

(2) From the declination station there should be known azimuths to two or more azimuth marks, preferably in opposite directions. These azimuth marks should be at least 1000 meters from the declination station, but they may be a minimum distance of 300 meters if necessary.

(3) Declination stations should be established in an area free from magnetic attractions.

d. When a declination station is available, declinate the aiming circle as follows:

(1) Set up the aiming circle directly over the declination station, then level the circle.

(2) With the upper motion, set the known azimuth to the azimuth mark on the scales of the instrument.

(3) With the lower motion, sight on the first azimuth mark.

(4) Release the magnetic needle. With the upper (recording) motion, center the needle.

(5) Read the declination constant directly from the scales (to the nearest 0.5 mil).

(6) Relevel the aiming circle, if necessary, and, using a second azimuth mark if one is available, repeat the above steps. (If a second azimuth mark is not available, use the first azimuth mark again.)

(7) Compare the two declination constants determined. If they agree within 2 mils, determine the mean, express it to the nearest whole mil using standard artillery expression, and record the mean and the date on the notation pad.

IF THE TWO VALUES DIFFER BY MORE THAN 2 MILS, REPEAT THE ENTIRE PROCESS.

e. In a rapidly moving situation, time may not permit the establishment of a declination station by battalion surveyors. Under such circumstances a declination station can be established by simultaneous observation or by observation of Polaris. See chapter 9.

f. A third method of declinating, if an accurate position can be determined, is to scale a grid azimuth to two distant points. The following procedures are used:

(1) Place the aiming circle over the selected point and level the instrument.

(2) Select two distant points that can be identified on a map and scale the direction to them from the occupied point.

(3) Using the direction scaled from the map, declinate the aiming circle by the procedures previously discussed.

(4) Compare the two values determined. They must agree within 10 mils.

(5) If the values determined agree within 10 mils, determine the mean, and record it on the notation pad. If the values do not agree within 10 mils, repeat the entire procedure.

A DECLINATION CONSTANT DETERMINED BY SIMULTANEOUS OBSERVATION OR FROM A MAP SHOULD BE VERIFIED AS SOON AS POSSIBLE.

8-8. Measuring Azimuth to a Point

a. The aiming circle can be used to measure an azimuth as follows:

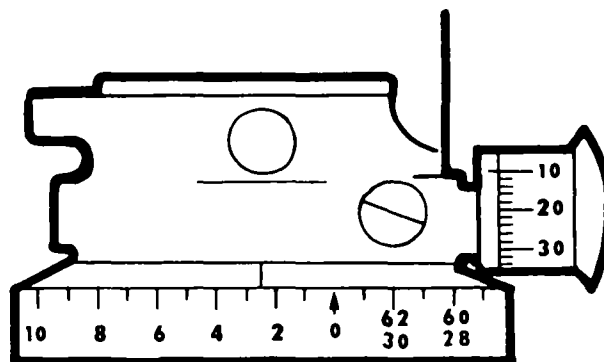
(1) Place the aiming circle so that the 0-3200 line is in an approximate north-south direction and the large 0 of the scale is toward the south.

(2) Check the notation pad to determine the declination constant for your aiming circle.

D.C. = 210
(date)

Then, with the upper motion, set off the declination constant.

(3) Release the needle and, with the lower motion, center the needle to direct the line of sight to magnetic north and the 0-3200 line of the instrument to grid north. When it is centered, the magnetic needle looks like this—



(4) Lock the needle and, with the upper motion, refer the line of sight to the desired point. Read the grid azimuth from the azimuth scale and the azimuth micrometer.

b. For greater accuracy, repeat this operation. If the two azimuth determinations agree within ± 2 mils, determine the mean, and record the measured grid azimuth to the nearest 0.1 mil. If they do not agree, repeat the entire procedure.

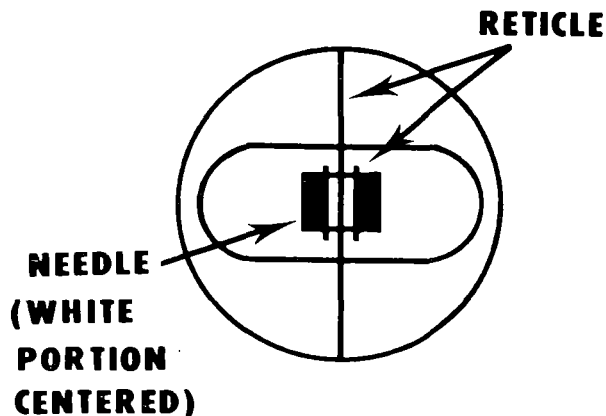
8-9. Care and Handling

The aiming circle must be treated with care. It will not stand abuse! The declination constant that is so painstakingly determined may very well be worthless if the aiming circle is dropped or handled in a rough manner. To get maximum service from the aiming circle:

a. Protect it from shock. Often in a fast-moving situation the executive officer (XO) or the chief of firing battery (CFB) will want to keep the aiming circle head attached to the tripod during movement. This practice is fine and reduces setup time. Extra care must be taken, however, to preclude damage to the instrument when transported in this manner.

b. The declination constants of the two aiming circles of the battery should be

compared periodically. To make this comparison—



(1) Set the aiming circles up at least 10 meters apart and level them.

(2) Using the method described in paragraph 8-8, have each instrument operator measure the azimuth to the other

instrument. (One operator will have to either add or subtract 3200 mils.) If the azimuths do not compare within + 10 mils, both aiming circles should be redeclinated as soon as possible.

c. Never attempt to force the rotation of any knob past the stops.

d. Keep the instrument clean and dry.

e. Clean the lens with a camel's hair brush and lens tissue ONLY.

f. Keep the magnetic needle *locked* any time it is not in use.

g. Place the aiming circle head cover over the aiming circle head for protection whenever it is to be left set up.

h. Be sure all tubular leveling vials are covered when not in use.

i. Be sure to rotate the azimuth knob until it is over the notation pad before attempting to replace the aiming circle head cover.

Section II. RECIPROCAL LAYING

8-10. General

Reciprocal laying is a procedure by which the 0-3200 line of one instrument and the 0-3200 line of another instrument are laid parallel. When the 0-3200 lines of an aiming circle and a panoramic telescope are parallel and the piece has been boresighted properly, the tube of the piece is parallel to both 0-3200 lines. The principle of reciprocal laying is based on the geometric theorem that if two parallel lines are cut by a transversal, the alternate interior angles are equal. The parallel lines are the 0-3200 lines of the instruments, and the transversal is the line of sight between the two instruments. The alternate interior angles are the equal deflections placed on the instruments (fig 8-1).

8-11. Procedures

a. After the 0-3200 line of the aiming circle has been established parallel to the direction of fire, the instrument operator, using the upper motion, sights on the lens of the panoramic telescope, reads the deflection on the azimuth and azimuth micrometer scales,

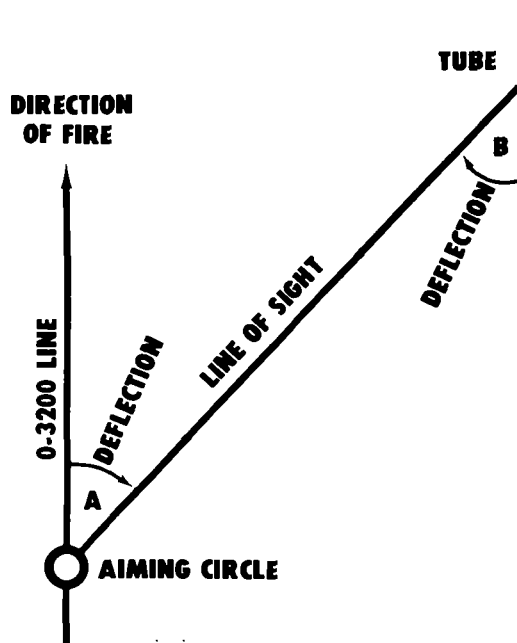


Figure 8-1. Principle of reciprocal laying.

and announces it to the gunner on the piece. IF THE WEAPONS ARE EQUIPPED WITH M12-SERIES SIGHTS, DEFLECTION

CANNOT EXCEED 3200 MILS; therefore, the red numbers on the aiming circle may have to be read. The gunner sets off the announced deflection on the panoramic telescope and orders the weapon to be shifted, and/or traverses the tube, until the line of sight through the panoramic telescope is again on the reflector of the aiming circle.

b. Because the panoramic telescope is offset laterally from the axis about which the carriage of the weapon is moved, the panoramic telescope is displaced horizontally. When the telescope has been sighted on the aiming circle, the gunner reports READY FOR RECHECK, and the instrument operator again sights on the lens of the telescope and reads and announces the deflection. This procedure is repeated until the gunner reports a difference of 0 mils between successive deflections. The piece has then been laid reciprocally.

c. The last deflection announced to each weapon should be recorded by the instrument operator in the event it is needed by the FDC in computing position corrections.

d. In some cases, all pieces will not be able to see the aiming circle, and one piece will be used to lay the others. If weapons are equipped with the M100-series panoramic telescopes, the readings between any two weapons will be 3200 mils apart. To prevent confusion, the gunner on the laying piece should add/subtract 3200 mils to/from his reading before announcing it to another howitzer. If the howitzer to which the laying gunner is referring is on his left, the gunner must add 3200; if it is on his right, he must subtract 3200. Reciprocal laying with the M107 or M110/M110A1 may not be possible because of the position of the sight mount and tube.

e. In order of *decreasing* accuracy, the methods available to lay the battery are:

(1) *M2 aiming circle method using the orienting angle.* This method requires that a known azimuth be established by the battalion survey section or by use of one of the hasty survey techniques discussed in chapter 9.

(2) *M2 aiming circle method using the*

magnetic needle. This method should be used only when surveyed data cannot be established.

(3) *M2 compass method.*

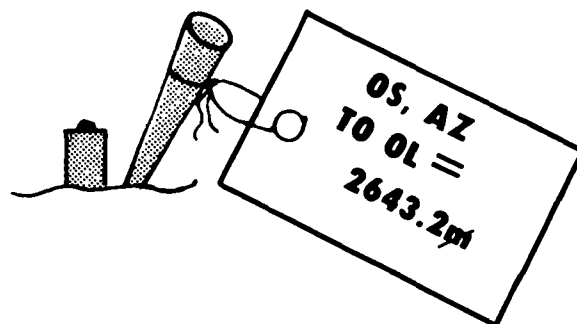
f. In addition, two methods of laying without the aiming circle (for emergency missions) are used. They are:

(1) *The aiming point-deflection method.*

(2) *The howitzer backlay method.*

8-12. Laying by Orienting Angle

a. To lay the battery by orienting angle, an orienting line must be established. The executive officer may be given the orienting line by the survey section, may find the information on a tag attached to the stake marking the orienting station (OS), or may have determined it himself through simultaneous observation or observation of Polaris (see chap 9).



b. Using the plumbline, he sets up the aiming circle over the small stake. The large stake points toward the end of the orienting line (EOL). The executive officer can compute the orienting angle (fig 8-2) by subtracting

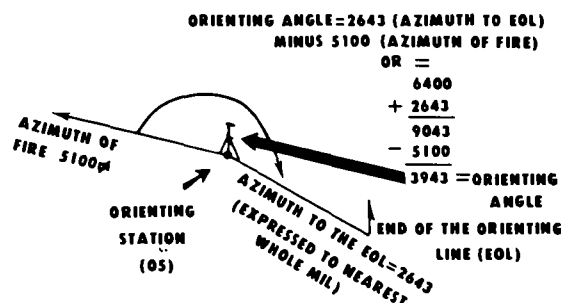


Figure 8-2. Computation of orienting angle.

the azimuth of fire from the azimuth of the orienting line. He uses the upper motion to set the orienting angle on the aiming circle and uses the lower motion to sight the aiming circle on the EOL. The 0-3200 line is now parallel to the azimuth of fire.

(1) The battery is being laid. The orienting angle is 3943.

(2) Set up the aiming circle over the orienting station.

(3) Using the UPPER motion, set off 3943, using black numbers only.

(4) Making certain that the index remains at 3943, use the LOWER motion and sight on the EOL. The line of sight now coincides with the orienting line. The 0-3200 line of the aiming circle is in the desired direction of fire.

(5) After the 0-3200 line of the aiming circle has been established in the desired direction of fire, the next step is to lay the battery reciprocally using the upper motion. This makes the tubes of the howitzers parallel to the 0-3200 line of the instrument, and thus oriented on the azimuth of fire.

ALWAYS VERIFY THE DIRECTION OF FIRE BY MEASURING THE AZIMUTH OF THE ORIENTING LINE OR BY MEASURING THE AZIMUTH OF FIRE AND COMPARING IT WITH THE COMPUTED AZIMUTH OF FIRE.

8-13. Laying by Grid Azimuth

If surveyed data are not available and hasty survey is not possible, the next best method of orienting the aiming circle is to use the magnetic needle.

a. To orient the aiming circle on a grid azimuth using the magnetic needle—

(1) Determine the instrument reading to be placed on the instrument by subtracting the azimuth of fire from the declination constant of the aiming circle (adding 6400 mils to the declination constant, if necessary).

(2) Using the UPPER motion, place this value on the aiming circle.

(3) Sight on magnetic north by centering (with the LOWER motion) the magnetic needle.

b. The next step is to lay the battery parallel, using the UPPER motion. Because laying by azimuth involves the use of the magnetic needle of the aiming circle, the instrument must be set up where it is free from magnetic attractions. The minimum distances that should be observed are:

Powerlines and electronic equipment 150 meters.

Railroad tracks, artillery*, tanks and vehicles 75 meters.

Barbed wire, personal weapons, and small metallic objects 10 meters.

*These distances apply to all calibers of cannon weapons.

The following is an example of laying the battery by grid azimuth:

(1) The command to lay the battery on azimuth 5350 has been received. The declination constant of the aiming circle is 200 mils.

(2) Subtract the azimuth of fire from the declination constant. Since the larger number (5350 mils) cannot be subtracted from the smaller number (200 mils), 6400 mils must be added to the smaller number. Thus, $6400 + 200 = 6600$ mils; $6600 - 5350 = 1250$. The horizontal, clockwise angle from the desired direction of fire to magnetic north (aiming point) is 1250 mils (fig 8-3).

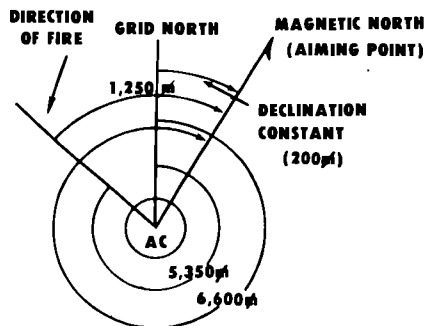


Figure 8-3. Principles of laying by grid azimuth.

(3) With the single 0 of the aiming circle nearest him and the 0-3200 line pointing generally in the direction of azimuth 5350, the instrument operator should use the UPPER motion to set off 1250.

(4) Making certain that the index remains at 1250, center the magnetic needle by using the LOWER motion. This action places the 0-3200 line of the aiming circle in the desired direction of fire; i.e., on grid azimuth 5350.

(5) After establishing the 0-3200 line of the aiming circle on grid azimuth 5350, lay the battery reciprocally by using the UPPER motion. This procedure places each howitzer tube on grid azimuth 5350.

8-14. Commands

The following commands are used in laying a battery with an aiming circle. The deflections announced are examples only. For brevity, only the exchange between the instrument operator and the gunner of number 3 is given.

Instrument operator:

**BATTERY ADJUST,
AIMING POINT
THIS INSTRUMENT.**

(All gunners identify the aiming point. Normally, pieces are laid in the order of their readiness.)

Gunner of number 3:

**NUMBER 3, AIMING
POINT IDENTIFIED.**

(Each gunner gives a similar response. Using the UPPER motion, the instrument operator turns the head of the aiming circle until the line of sight is on the telescope of the number 3 piece and reads the azimuth and azimuth micrometer scales.)

Instrument operator:

**NUMBER 3,
DEFLECTION 3091.**

Gunner of number 3:

**NUMBER 3,
DEFLECTION 3091.**

(The gunner then sets the deflection on his sight and traverses the weapon until he is sighted back on the aiming circle.)

Gunner of number 3:

**NUMBER 3,
READY FOR RECHECK.**

(The instrument operator again turns the head of the aiming circle until the line of sight is on the telescope of the number 3 piece and announces the deflection.)

Instrument operator:

**NUMBER 3,
DEFLECTION 3093.**

(This indicates a difference of 2 mils from the original deflection of 3091, which the gunner now has on the panoramic telescope. The gunner sets 3093 on the telescope and again traverses the tube until he is sighted on the aiming circle. Meanwhile, the instrument operator may or may not proceed with the laying of the other pieces. As a general rule, when the gunner of any piece announces a difference of 10 mils or less, the instrument operator continues to lay that particular piece until it is laid.)

Gunner of number 3:

**NUMBER 3,
DEFLECTION 3093,
2 MILS.**

The gunner then announces:

**NUMBER 3, READY
FOR RECHECK.**

Instrument operator:

**NUMBER 3,
DEFLECTION 3093.**

Gunner of number 3:

**NUMBER 3,
DEFLECTION 3093,
0 MILS.**

(Rechecking of each piece must continue in this manner until the deflection announced by the instrument operator and the deflection on the panoramic telescope are identical.)

Instrument operator:

**NUMBER 3
IS LAID.**

8-15. Laying the Battery Without an Aiming Circle

If an operational aiming circle is not available, the following methods of laying the battery may be used. The methods in *b* and *c* below are recommended for emergency situations.

a. M2 compass method.

(1) Place the M2 compass on a steady object away from magnetic attractions and where it can be used as an aiming point for the base piece. The aiming circle tripod, if available, is excellent for this purpose.

(2) Measure the azimuth to the panoramic telescope of the base piece. Compute a deflection by subtracting the announced azimuth of fire from the azimuth measured to the panoramic telescope of the base piece (adding 6400 mils, if necessary.)

(3) Command:

**BASE PIECE ADJUST (or
NUMBER (so-and-so) ADJUST),
AIMING POINT THIS INSTRUMENT,
DEFLECTION (so much).**

The gunner sets the announced deflection on the sight, moves the weapon and/or traversing mechanism until he is sighted on the instrument, and announces:

**NUMBER (so-and-so), AIMING
POINT IDENTIFIED, DEFLECTION
(so much).**

The instrument operator commands:

**BASE PIECE IS LAID, BATTERY
ADJUST, ON BASE PIECE LAY
PARALLEL (or ON NUMBER (so-and-
so) LAY PARALLEL).**

(4) The gunner of the base piece then reciprocally lays the other pieces. He uses the panoramic telescope and the procedure explained in paragraph 8-11.

**REMEMBER TO SET THE DECLI-
NATION CONSTANT ON THE M2
COMPASS.**

b. Aiming point-deflection method. The aiming point and deflection method is used primarily for a rapid occupation of position; however, it can be used for a deliberate occupation in the absence of an aiming circle or an M2 compass. The XO should lay the base piece and then have the base piece gunner lay the battery reciprocally.

(1) Determine the azimuth from the battery center to a distant aiming point (DAP). To compute a deflection, subtract the *back-azimuth* of fire from the azimuth determined to the distant aiming point.

(2) To lay the battery, command:

**BATTERY ADJUST, AIMING POINT
(so-and-so) (location), DEFLECTION
(so much).**

(3) Each gunner sets off the announced deflection, sights on the aiming point by traversing, then announces:

**NUMBER (so-and-so), AIMING POINT
IDENTIFIED, DEFLECTION
(so-much).**

(4) When all sections have so reported command:

THE BATTERY IS LAID.

WHEN THE BATTERY IS LAID BY THE AIMING POINT AND DEFLECTION METHOD, THE SHEAF TENDS TO CONVERGE IF THE AIMING POINT IS TO THE FRONT AND TENDS TO DIVERGE IF THE AIMING POINT IS TO THE REAR; THEREFORE, IT IS PREFERABLE TO USE AN AIMING POINT ON THE FLANK.

c. Howitzer backlay method. In an emergency, when time is critical and a DAP is not available, the howitzer backlay method may be used. With training and practice, the battery can perform this method as accurately and quickly as the aiming point-deflection method. Upon receipt of a fire mission, the XO pulls into a firing position and alines the front of his vehicle roughly on the azimuth of fire. His driver assists him in alining two stakes and the battery is laid by the following procedure:

(1) The XO drives in the rear stake and uses the M2 compass to aline the far stake on the azimuth of fire. He then drives in the far stake. (Distance between stakes should be equal to the length of the howitzer.) (A)

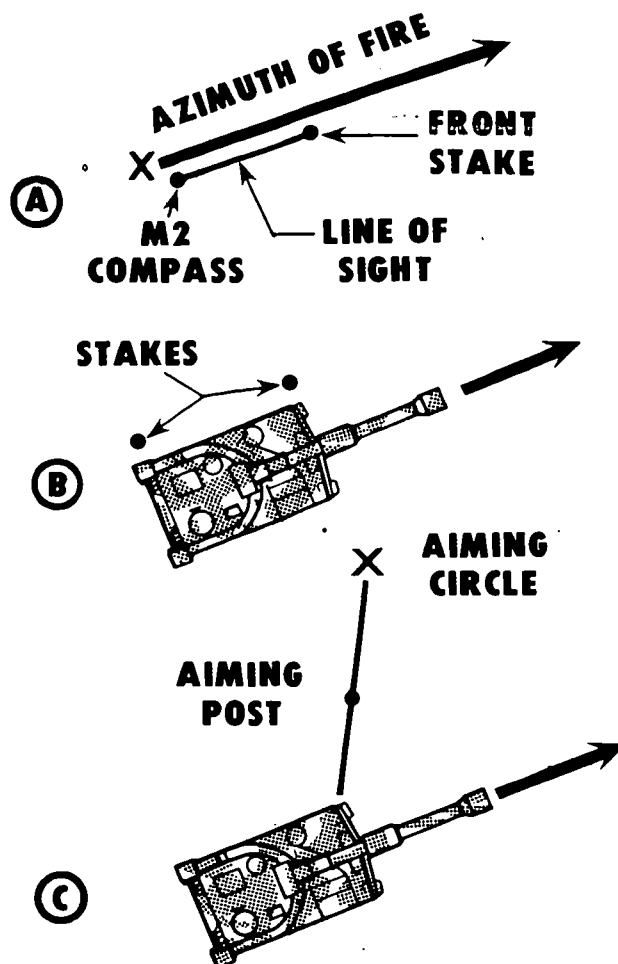
(2) The XO guides the base piece into position and alines it parallel to the stakes. With the tube still in the center of traverse position, the base piece fires the first round with the quadrant and charge determined by the XO or FDC. (B)

(3) While the base piece is firing the first round, one man sets up the aiming circle in the appropriate position to lay the rest of the battery. After the first round is fired, the instrument operator commands:

**BASE PIECE, AIMING POINT
THIS INSTRUMENT, REFER.**

The gunner on the base piece refers to the aiming circle and replies:

**BASE PIECE, AIMING POINT
IDENTIFIED, DEFLECTION
(so much).**



The instrument operator places the referred reading on the aiming circle, sights on the base piece with the lower motion, and then lays the remainder of the battery by standard procedures. The gunner on the base piece places an aiming post halfway between himself and the aiming circle to be used as an aiming point, and the remaining pieces emplace collimators. (C)

8-16. Establishing Aiming Points

a. Under normal circumstances, after the battery has been laid, the crew of each piece is directed to set up the collimator or aiming posts before the tube is moved. The deflections at which the aiming points are established are recorded by the gunner. Furthermore, the direction in which the battery is initially laid and the corresponding deflection are used as references from which

the FDC can derive firing deflections for future targets.

b. The collimator is the primary aiming point and is placed 4 to 15 meters from the sight of the weapon. When the collimator is emplaced, three numbers, such as (5, 0, 5), or eleven graduations must be visible in the reticle. If possible, place the collimator under cover to the left or left front of the weapon. Be sure that the collimator is emplaced so that the power cable will reach the weapon (SP weapons only). When aiming posts are used, the far aiming post should be placed 100 meters from the piece and the near aiming post *must* be placed halfway between the piece and the far aiming post.

c. As soon as the battery is laid and the aiming point(s) is (are) emplaced, the XO should have the gunners of all pieces refer to a distant aiming point if one is available. This DAP can be used as the primary aiming point if something happens to the collimator or aiming posts. For example, the XO may command:

*AIMING POINT, STEEPLE RIGHT
FRONT, REFER, RECORD
REFERRED DEFLECTION.*

Each gunner refers to the steeple and records the deflection for future use.

8-17. Verifying Laying for Direction

a. After the battery has been laid, there are certain checks that should be made to insure that no weapon has been laid in error and that the pieces have been laid parallel and in the proper direction. To check parallelism, each gunner checks reciprocally with at least one other piece. If the deflections used by the gunners agree, the pieces are parallel. *Caution must be used in checking with the M100-series sights, since the reading from one sight to another will differ by 3200 mils.* Further, one of the firing battery supervisors should walk the line of metal and visually check the parallelism of the tubes.

b. As soon as time permits, the following check should be made.

(1) With another aiming circle (if available) command:

*NUMBER (so and so),
AIMING POINT
THIS INSTRUMENT, REFER.*

(2) The gunner of the piece indicated announces AIMING POINT IDENTIFIED, turns the sight of the piece until the line of sight is on the designated instrument, and announces the reading on the azimuth counter (or nonslipping azimuth scale) as:

*NUMBER (so-and-so), DEFLECTION
(so much).*

(3) The instrument operator sights on the panoramic telescope of the designated piece.

(4) If the deflection read by the gunner does not agree with that read from the instrument, the instrument operator can correct it by giving the gunner the proper deflection and re-laying the weapon.

8-18. Laying by Aircraft, High Airburst, or Flare

a. The battery may be laid initially for direction by sighting with an instrument on an aircraft, a high airburst, or a flare. This procedure is valid when the entire battalion is placed on a common direction.

b. When no visible point is suitable for use as an aiming point, an *aircraft* may fly over the battery position toward, or away from, a point in the target area to indicate an azimuth of fire.

c. If a *high airburst* or a *flare* is to be used, it should be fired over the target area. The high airburst is fired by another unit that has been laid previously for direction. The flare may be fired by an air observer or a ground observer.

d. To lay the battery by aircraft, high airburst, or flare, use the following procedure:

(1) Set up the aiming circle where it can be used as an aiming point by all pieces.

(2) Zero the azimuth scale and azimuth micrometer scale and, using the lower motion, aline the vertical hairline on the aircraft, airburst, or flare.

(3) Using the upper motion, lay the pieces reciprocally by standard procedures.

8-19. Training

a. The battery must be prepared to deliver fire as quickly as possible after getting to the firing position. This means that the laying process must be completed as quickly as possible. Personnel who lay the battery must be *fast and accurate*. This requires training.

b. As a minimum, the following personnel should know how to lay the battery:

All officers.

The chief of firing battery.

The gunnery sergeant.

The first sergeant.

All howitzer section chiefs.

c. Training should start initially in a local training area. A card made up in the format indicated in table 8-1 should be issued to each trainee to use until he has mastered the math and procedural steps. Trainees should be encouraged to use the memory aids to jog their memories.

d. GTA 6-1-2, the Firing Battery Supervisor's Ready Reference Square, is very handy for trainees to use after they have been

trained in laying procedures.

e. How to avoid common mistakes and malpractices discussed in appendix G should be emphasized.

f. To maximize training effectiveness, a howitzer with a crew of at least a gunner and an assistant gunner should be provided for each trainee. Radio or wire communications should be established between the aiming circle and the howitzer. The trainer should emphasize use of proper commands.

g. As soon as the trainee has mastered the math and procedural steps for all methods of laying, he should be drilled frequently to develop speed in—

Setting up and leveling the aiming circle.

Determining initial instrument readings.

Centering the magnetic needle of the aiming circle.

Scaling azimuths from a map.

Accurately measuring azimuths with the M2 compass. This will develop the proficiency needed to lay by the howitzer back-lay method.

h. The commander should designate various people to lay the battery during field training exercises in order to maintain proficiency and develop confidence.

Table 8-1. How to Lay the Battery

WITH THE M2 AIMING CIRCLE		
If survey is available, use the azimuth (AZ) to the end of the orienting line (EOL) and AZ of fire		
SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	Take the fire out of Old Lady	Az to EOL - az of fire = Orienting Angle (OA).
Do this SECOND	U	Set the OA on the aiming circle with the Upper motion
Do this THIRD	L	Sight on the EOL with the Lower motion
Do this LAST	U	Sight on the pantel with the Upper motion
REMEMBER: ULU		

Table 8-1. How to Lay the Battery—continued

If no survey is available, use the declination constant (DC) and the AZ of fire.

SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	S A D	Subtract the Az of fire from the DC.
Do this SECOND	U	With the Upper motion, set the remainder on the aiming circle.
Do this THIRD	L	With the Lower motion, center magnetic needle.
Do this LAST	U	With the Upper motion, sight on the panel.
REMEMBER: SAD—ULU		

WITH THE M2 COMPASS

Use AZ measured to base piece with the compass and the AZ of fire.

SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	S A M	Subtract the AZ of fire from the AZ Measured to base piece.
Do this LAST		Using proper commands, announce the resulting deflection.
REMEMBER: SAM		

BY THE AIMING POINT—DEFLECTION METHOD

Use the AZ to the distant aiming point (DAP) and the AZ of fire.

SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	AP-BAF	Aiming Point azimuth (minus) the Back Azimuth of Fire.
Do this LAST		Using the proper command, announce the resulting deflection.
REMEMBER: AP-BAF		

Table 8-1. How to Lay the Battery—continued

BY THE HOWITZER BACKLAY METHOD

Using the M2 compass, aline two stakes on the azimuth of fire and position the base piece parallel to the stakes—

SEQUENCE**PROCEDURES**

Do this FIRST	Set up the aiming circle where it can be seen by all the pieces and level it.
Do this SECOND	After the base piece fires the first round, have the gunner refer to the aiming circle.
Do this THIRD	With the UPPER motion, place the referred deflection on the aiming circle.
Do this FOURTH	With the LOWER motion, sight on the panoramic telescope of base piece.
Do this LAST	With the UPPER motion, lay the remainder of the battery.

Section III. DETERMINING AND REPORTING LAY DATA**8-20. Checks**

a. The fire direction center will often require a check on weapon direction for various operations (construction of firing charts, checks on laying, checks on data fired, etc). Normally, these checks are made immediately following a registration.

b. Two methods of *reporting* (paragraphs 8-21 and 8-22) reveal any sloppy procedures; e.g., taking up the sight picture improperly or failing to level bubbles. *Measuring* provides a check on the accuracy of the battery location and lay. When errors are detected, the FDC should modify the adjusted data determined during a registration as appropriate.

**IT IS CRITICAL THAT THE
TUBE OF THE REGISTERING
PIECE NOT BE MOVED PRIOR
TO THESE CHECKS.**

8-21. Reporting Adjusted Deflection

When the command:

**REPORTED ADJUSTED
DEFLECTION**

is received after registration, the XO goes to the base piece and verifies that the sight mount is level and that the correct sight picture exists. If the sight picture is incorrect, the XO corrects it by moving the head of the sight. Then he reads the deflection from the sight of the base piece and reports to FDC:

ADJUSTED DEFLECTION
(so much).

8-22. Reporting Adjusted Azimuth or Orienting Angle

a. After a registration, the FDC may command:

REPORT ADJUSTED AZIMUTH

(or orienting angle if the battery is laid by orienting angle) before END OF MISSION is announced to the guns. The adjusted deflection of the piece is determined at this time and noted. Then the XO determines the difference between this deflection and the initial deflection. He applies that difference to the azimuth or orienting angle on which the piece was previously laid and reports:

**ADJUSTED AZIMUTH (or
ORIENTING ANGLE)**
(so much).

AN INCREASE IN DEFLECTION
CAUSES AN EQUAL DECREASE
IN AZIMUTH AND AN EQUAL
INCREASE IN ORIENTING ANGLE.

b. Here's an example. The battery is laid on azimuth 5000, deflection 2800. After firing, the adjusted deflection was 2915. The FDC commands:

REPORT ADJUSTED AZIMUTH.

(1) Deflection 2800 to deflection 2915 equals an increase of 115.

(2) Subtract 115 from the azimuth of fire.
 $5000 - 115 = 4885$.

(3) The XO reports:

ADJUSTED AZIMUTH 4885.

**8-23. Measuring the Azimuth of the
Direction of Fire**

When the command:

MEASURE THE AZIMUTH

is received, the direction of the tube of the base piece is actually measured with an aiming circle. The procedure for measuring the azimuth is as follows:

a. Orient the 0-3200 line of the aiming circle generally parallel to the tube of the piece.

b. Command the gunner of the base piece to refer the sight to the aiming circle and announce the deflection.

c. With the upper motion, set the announced deflection on the aiming circle. Remember, if the weapon is equipped with an M12-series sight, the red numbers may have to be used. If, after setting the reading on the aiming circle, the line of sight is roughly

toward the piece, the right numbers have been used.

d. With the lower motion, turn the telescope until the vertical hairline is on the sight of the piece.

THE 0-3200 LINE OF THE AIMING
CIRCLE IS NOW PARALLEL TO
THE TUBE OF THE PIECE.

e. Release the magnetic needle and, with the upper motion, center it.

f. Subtract the final instrument reading from the declination constant of the aiming circle.

g. Report the result as:

AZIMUTH (so much).

Here's an example:

FDC:

MEASURE THE AZIMUTH.

Instrument operator:

**NUMBER 3 (base piece), AIMING
POINT THIS INSTRUMENT, REFER.**

Gunner:

**NUMBER 3, AIMING POINT
IDENTIFIED, DEFLECTION 2415.**

Instrument operator:

NUMBER 3, DEFLECTION 2415.

The declination constant is 200 mils. The instrument operator now centers the magnetic needle and determines his instrument reading to be 1560. He subtracts this from the declination constant and reports:

AZIMUTH 5040 MILS.

8-24. Measuring the Orienting Angle

The orienting angle is measured in the same manner as the azimuth except that—

a. Instead of centering the magnetic needle, the instrument operator, with the upper motion, sights the instrument on the end of the OL.

b. The final reading is the orienting angle (see fig 8-4).

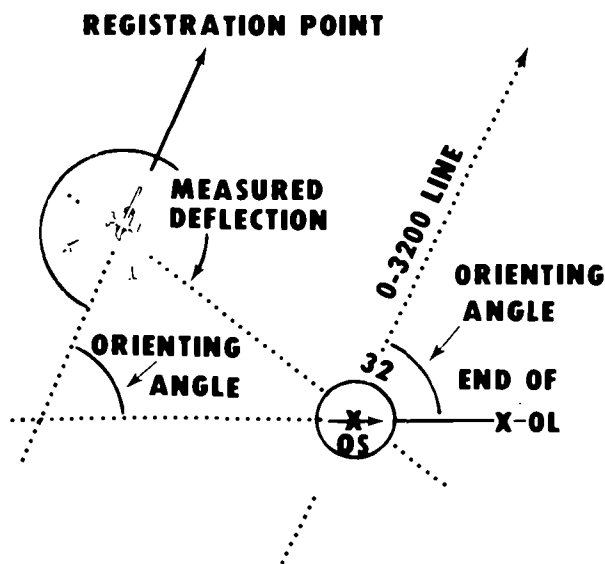


Figure 8-4. Measuring the orienting angle.

8-25. Correction of Boresighting Error After Registration

a. Tactical considerations may necessitate registration before sight tests and adjustments can be made. In such cases the pieces must be boresighted at the most practicable time, usually during a lull in firing. If boresighting discloses that the 0-3200 line of the sight is not parallel to the tube, corrective measures must be taken and reported to the fire direction center.

b. When a deflection is read from a sight or when an azimuth is measured, the deflection or azimuth determined is that of the 0-3200 line as read from the azimuth counter. *Only if the weapon is boresighted properly is the deflection or azimuth that of the tube.* When the FDC commands:

**MEASURE THE AZIMUTH
(ORIENTING ANGLE),**

the azimuth (orienting angle) of the tube is desired. Therefore, if the weapon is not boresighted properly, the azimuth (orienting angle) measured is inaccurate by the amount of the error in boresighting.

c. At the first opportunity, weapons are boresighted. The azimuth counter is used during boresighting. The tube is pointed at the aiming point (either at a distant aiming point, at the appropriate "butterfly" on the test target, or at deflection 3200 when using an alinement device), and the sight is zeroed. If the sight is pointed to the right of the appropriate aiming point, the tube is pointed to the left of the 0-3200 line of the sight. It follows that any azimuth measured prior to this time was greater than the azimuth of the tube and that any orienting angle measured was smaller than the tube orienting angle. If the sight is pointed to the left of the appropriate aiming point, the measured azimuth is less than the azimuth of the tube and the measured orienting angle is larger than that of the tube. The amount of the error is determined by referring the sight to the aiming point and reading the deflection. This deflection is compared with 3200, and the difference is the amount of the error in boresight. The previously determined azimuths or orienting angles are corrected, boresighting is completed, and the actions taken are reported.

Example 1: A battery has occupied a position. Before the base piece can be boresighted, a registration is conducted. At the conclusion of the registration, the executive officer determines 2595 to be correct on the azimuth counter (3195 on the reset counter) and measures an azimuth of 1800. A short time later, the piece is boresighted. With the tube pointed at the appropriate aiming point and the azimuth counter reading 3200, the sight is pointed to the right of the aiming point. The XO then refers the sight to the aiming point and reads a deflection of 3192 mils. The tube is pointed 8 mils to the left of the 0-3200 line of the sight (①, fig 8-5). Therefore, the azimuth of the tube after registration is 1792 (1800-8). When the weapon is

boresighted, a deflection of 2595 (3195 on the reset counter) will *not* point the tube on azimuth 1792. To correct this error, the XO *adds* 8 mils to the deflection and it becomes 2603 as read on the azimuth counter (3203 on the reset counter) (②, fig 8-5). The XO then directs the gunner to return the base piece to the initial lay by setting the azimuth counter deflection at 2600 and the reset counter at 3200. After correcting the boresighting, the XO reports:

ERROR OF 8 MILS IN BORE-SIGHTING ON BASE PIECE, CORRECT AZIMUTH WHEN LAID ON REGISTRATION POINT IS 1792, CORRECT ADJUSTED DEFLECTION 3203, BORESIGHTING HAS BEEN CORRECTED.

Example 2: Assume that in example 1 an orienting angle of 853 mils was measured. After the 8-mil error in boresighting is determined, the corrected orienting angle is 861 mils (fig 8-6). The XO reports:

ERROR OF 8 MILS, CORRECT ORIENTING ANGLE IS 861, CORRECT ADJUSTED DEFLECTION 3203, BORESIGHTING HAS BEEN CORRECTED.

8-26. Site by Firing (Exec's High Burst)

Upon completion of an observed firing chart registration with fuze time, the FDC may command:

**OBSERVE HIGH BURST,
MEASURE ANGLE OF SITE,
3 ROUNDS,**

followed by the adjusted data. This requires the XO to report the observed angle of site to the mean burst center of three rounds. The procedure for measuring the angle of site is as follows:

a. Place the aiming circle near the base piece and have the base piece lay it

reciprocally. The aiming circle is now oriented on the direction of fire.

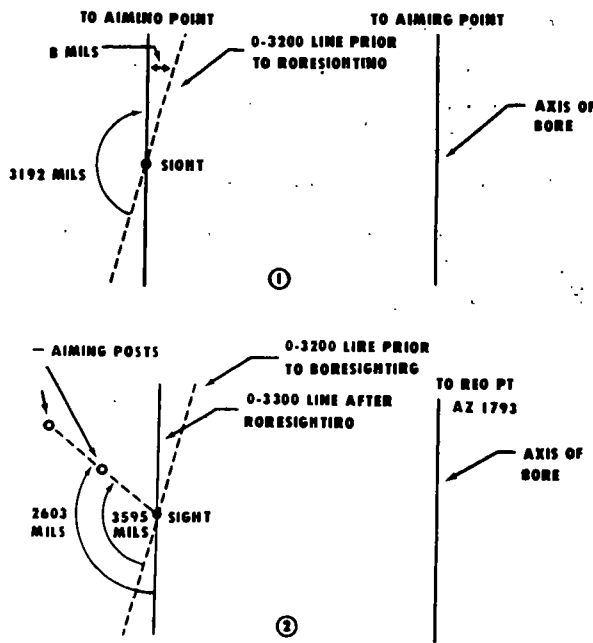


Figure 8-5. Example of error revealed by boresighting.

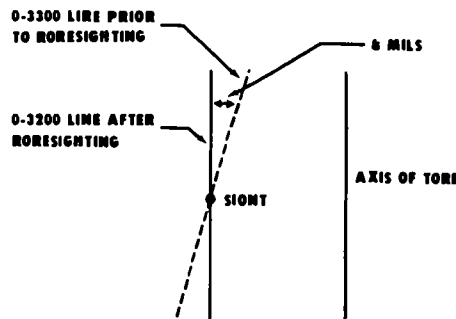


Figure 8-6. Example of error in orienting angle due to error in boresighting.

b. Determine the angle of site necessary to place the burst of the rounds fired by the base piece above the crests. Place this value on the vertical scales of the aiming circle.

c. Give the necessary commands to the base piece to place the bursts above any crests visible from the battery area.

d. Command the base piece to fire.

e. With the lower motion, place the *vertical* hairline of the aiming circle on the burst. Record the angle of site.

f. Fire two more rounds, and record the

angle of site for each.

g. Report to the FDC the mean observed angle of site and the quadrant elevation fired.

8-27. Training

Training in the proper methods of measuring and reporting piece direction should be a part of training personnel to lay the battery. The personnel indicated in paragraph 8-19 should receive this training. Use a card like the one in table 8-2 to assist the trainee in remembering the procedural steps.

Table 8-2. How to Measure and Report Piece Direction

HOW TO MEASURE THE ORIENTING ANGLE		
SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	U	With the Upper motion, place the deflection read to you by the gunner on your aiming circle.
Do this SECOND	L	With the Lower motion, sight on the howitzer panoramic telescope.
Do this LAST	U	With the Upper motion, sight on the end of the orienting line.
THE READING IS THE ORIENTING ANGLE		
TO MEASURE THE AZIMUTH OF FIRE		
SEQUENCE	MEMORY AID	PROCEDURES
Do this FIRST	U	With the Upper motion, place the deflection read to you by the gunner on your aiming circle.
Do this SECOND	L	With the Lower motion, sight on the howitzer panoramic telescope.
Do this THIRD	U	With the Upper motion, center the magnetic needle.
Do this LAST	SID	Subtract the Instrument reading (on the aiming circle) from the Declination constant.
THE RESULT IS THE AZIMUTH OF FIRE		
TO REPORT PIECE DIRECTION		
Go to the howitzer.		
Check to insure that the bubbles on the sight mount are level; if they are not, level them.		
Check the sight picture; if it is incorrect, correct it by moving the head of the panel only. DO NOT TRAVERSE THE TUBE.		
Read and report the deflection on the panel.		



CHAPTER 10

MINIMUM QUADRANT ELEVATION

10-1. General

In training and in combat we must insure that artillery fire lands on the intended target—that it does not hit an intervening crest between the guns and the target. The XO is responsible for determining the lowest quadrant elevation that can be safely fired from his battery position and that will insure that projectiles clear all friendly crests visible from the battery position. The FDC must also insure that rounds clear friendly *intermediate* crests. The computation procedures in this chapter can be used for both.

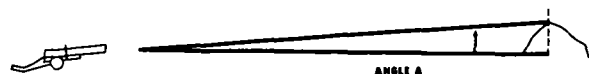
10-2. Elements of Computation

Whenever possible, the minimum quadrant elevation (min QE) rapid fire tables (appendix F) should be used for computing minimum quadrant elevation. An explanation of the computation of min QE with the rapid fire tables is contained on page F-1. The XO, however, must be familiar with the elements that make up this computation and how they are determined. Step-by-step procedures for computing min QE (if the rapid fire tables CANNOT be used) are in this chapter. These are the elements that make up the computation.

a. *Range to crest* is the horizontal distance between the piece and the crest, expressed to the nearest 100 meters. Procedures for measurement are discussed in paragraph 10-4.



b. *Angle a* is the greatest angle of site to crest measured by all weapons (para 10-3).



c. *Angle b* is the vertical angle corresponding to the required vertical clearance for friendly elements. For quick, time, and *unarmed* proximity (VT) fuzes, a vertical clearance of 5 meters is used. For armed VT fuzes, see paragraph 10-8.



d. *Angle c* is the complementary angle of site (comp site). It is the comp site factor for the appropriate charge at the piece-to-crest range multiplied by the *sum* of angles a and b.



e. *Angle 1, site*, is the sum of angles a, b, and c.

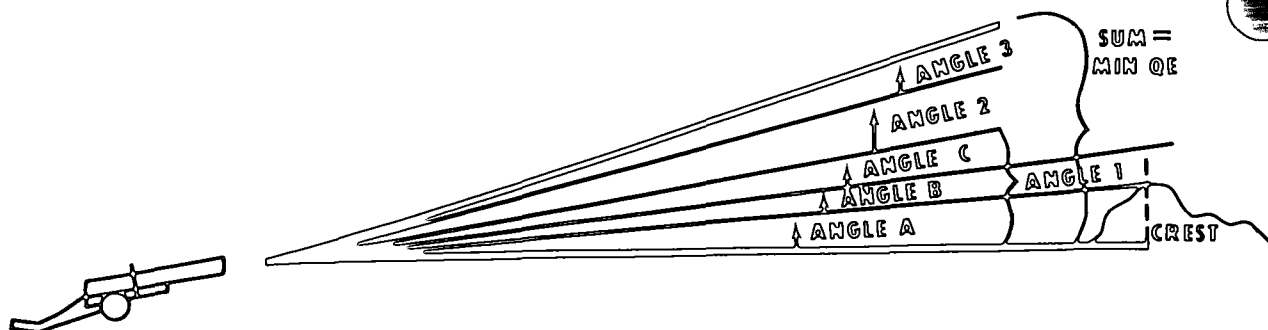


f. *Angle 2* is the elevation for the appropriate charge corresponding to the piece-to-crest range.



g. *Angle 3* is a safety factor equivalent to the value of 2 forks (from table F of the tabular firing tables) for the appropriate charge at the piece-to-crest range.

h. The sum of angles 1, 2, and 3 is the minimum quadrant elevation.



10-3. Measuring Angle of Site to Crest

As soon as his piece is laid, the chief of section measures the angle of site to the crest and reports it to the XO. To measure the angle of site to crest, the chief of section, sighting along the lowest element of the bore, has the tube traversed across the probable field of fire and has the tube elevated until the line of sight clears the crest at the highest point. He then centers all bubbles on the elevation mount and reads the angle of site to the crest from the elevation counter. This angle may also be measured with a gunner's quadrant placed on the quadrant seats. This angle of site is reported to the XO.

10-4. Measuring Range to Crest

The most commonly used methods of measuring range to crest are:

a. Mil relation. The mil relation is a particularly good method when the tactical situation permits its use. The mil relation method involves the use of the panoramic telescopes of the flank pieces, one aiming circle and one panoramic telescope, or two aiming circles. Usually, it is the most practical to use the panoramic telescopes of the flank pieces. For example, the battery has been laid parallel and the distance between flank pieces is 150 meters (fig 10-1). The steps for the mil relation method are—

(1) The gunners of the flank pieces refer to exactly the same point on the crest.

(2) Each of the flank gunners announces the deflection to the point on the crest from his piece.

(3) The apex angle (angle X) is determined from these two deflections as indicated in figure 10-1.

(4) The range in meters to the crest is determined by dividing the battery front in meters times 1,000 by the apex angle in mils. The base may be measured by pacing or by subtense if the flank pieces are intervisible. See chapter 9 for details on the use of subtense.

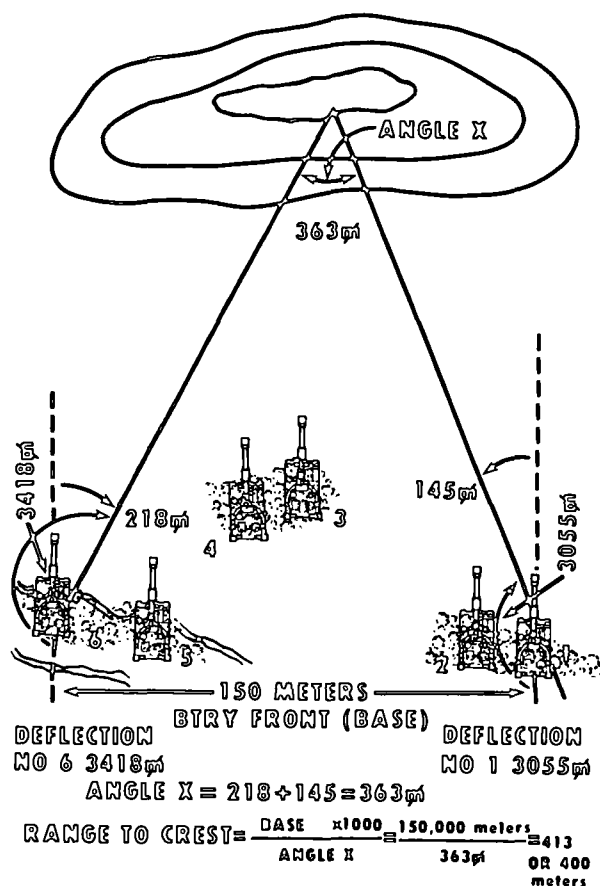


Figure 10-1. Determining piece-crest range by use of panoramic telescopes.

b. *Taping* is an accurate method; however, it is time consuming and is used only when time and terrain permit.

c. *Map measurement* is a fast, accurate method that is not affected by adverse terrain features. The chart operator plots the location of the position area, determines the highest point of the crest, and measures the distance with the appropriate scale.

d. *Pacing* is a time-consuming method, dependent on the distance to the crest and the accessibility of the crest.

e. *Estimation* may be used when more accurate means are not feasible.

10-5. Computation for Fuzes Other than VT

a. The XO performs the computations indicated in this section if the sum of angles a and b exceeds 300 mils or if the rapid fire tables are not available. All angles are determined and expressed to the next higher whole mil. The following is an example of this computation. The range to crest is 1100 meters; the greatest angle of site to crest reported is +16 mils. The weapon is the 155-mm howitzer M109A1, and charge 3 green bag will be fired. The XO—

(1) Selects and records the greatest angle of site (angle a) reported by the chiefs of section. Angle a = +16 mils.

(2) Determines the value in mils of angle b, the vertical clearance angle. He uses the GST to divide the vertical clearance in meters (5 meters) by the piece-to-crest range in thousands (1.1). This value, read under the M gagepoint, is 4.6, which is *expressed to the next higher whole mil*. Angle b = +5 mils.

(3) Determines angle c (comp site) by multiplying the comp site factor corresponding to the piece-to-crest range (or the next higher listed range in table G of the TFT if that range is not listed) by the sum of angles a and b. Angle a + angle b = 21. The comp site factor corresponding to 1500 meters (range 1100 is not listed in table G) is +0.010. Therefore $+21 \times 0.010 = +0.210$. Once a value for comp site has been determined, it

must be *expressed to the next higher whole mil*. Angle c = +1 mil.

(4) Determines angle 1 (site) by adding together angles a, b, and c. Angle 1 = +22 mils.

(5) Determines elevation for the piece-to-crest range (angle 2). If this value is not a whole number, it is *expressed to the next higher whole mil* (73.4 expressed to 74). Angle 2 = +74 mils.

(6) Determines the value of 2 forks (table F of the TFT) at piece-to-crest range (angle 3). 2 forks = +2 mils.

(7) Adds angles 1, 2, and 3 to determine the Min QE.

$$22 + 74 + 2 = 98 \text{ mils}$$

b. A single narrow obstruction, such as a tree, that will mask only one piece at a time is not considered in computing minimum quadrant elevation. If a piece cannot be fired safely, it is called out of action. If the XO does not want to call the piece out of action, he may have the piece moved so that it can be fired safely or he may direct that the mask (obstruction) be removed.

10-6. Computation for VT Fuzes (Low-angle Fire)

a. The method of computing minimum quadrant elevation for firing a projectile fuzed with an M513, M514, or M728 fuze depends on the method in which the fuze is employed.

b. The proximity (VT) fuze is designed to arm 3 seconds prior to the time set on the fuze; however, some VT fuzes have armed as early as 5.5 seconds prior to the time set on the fuze. **Because of the probability of premature arming, a safety factor of 5.5 seconds must be added to the time of flight to the point where arming is permitted. Since time on the setting ring is set to the whole second, the time determined is rounded up to the whole second, and this is the minimum safe time. A VT fuze can never arm earlier than 2 seconds time of flight.**

c. In *noncombat* situations the XO

determines the minimum safe time by adding 5.5 seconds to the time of flight to the minimum range line as shown on the safety card. The minimum quadrant elevation determined by the XO for fuzes quick and time is also valid for fuze VT, because firing the VT fuze at a fuze setting less than the minimum safe time is not authorized.

d. In *combat* situations the XO determines the minimum safe time and minimum quadrant elevation at the piece-to-crest range or the minimum arming range, *whichever is greater*.

e. When the projectile is to be fired with the VT fuze set at a time *less than the minimum safe time*, allowance must be made for vertical clearance of friendly elements. Vertical crest clearances for M513 and M514 VT fuzes fired over ordinary terrain are shown below.

Table 10-1. Vertical Clearance

WEAPON	VERTICAL CLEARANCE
105-mm HOWITZER	80 METERS
155-mm HOWITZER	100 METERS
8-INCH HOWITZER	150 METERS

f. For the M728 fuze the vertical clearance is *70 meters* for all calibers. If the projectile is to be fired over marshy or wet terrain, the average height of burst will increase and, therefore, the vertical clearance shown in table 10-1 should be increased by 50 percent. If the projectile is to be fired over water or snow, the vertical clearance shown in table 10-1 should be increased by 100 percent.

g. The XO must determine the minimum arming range before computing minimum quadrant elevation for firing a projectile with a VT fuze.

(1) He converts the minimum arming time, 2 seconds time of flight, to a minimum arming range. Because this range is directly affected by muzzle velocity, it varies for different weapons and charges. After this range has been determined, he compares it with the piece-to-crest range and uses the *greater* of the two in computing the minimum

safe time and minimum quadrant elevation.

(2) To determine the minimum arming range, he enters the firing tables for the particular charge(s) and weapon system, locates the time of flight of 2 seconds (table F, column 7), and reads the range (column 1) corresponding to the minimum arming time. If the exact time of flight of 2 seconds is not listed, he uses the range corresponding to the first time of flight *greater* than 2 seconds.

(3) To determine the minimum safe time, he adds 5.5 seconds to the time of flight corresponding to the range determined above. If the value is not a whole second, he expresses it up to the next higher whole second.

h. The minimum quadrant elevation for fuze VT, when a fuze setting less than the minimum safe time is fired, is based on piece-to-crest range or minimum arming time range, **WHICHEVER IS GREATER**.

10-7. Computation Based on Piece-to-Crest Range

If the piece-to-crest range is greater than the minimum arming time range (fig 10-2), the XO determines and reports the minimum quadrant elevation for the crest based on the piece-to-crest range. For example—

The howitzers are 155-mm M109A1 and charge 4 green bag is to be fired. The greatest angle of site reported by chiefs of section is 16 mils, and the piece-to-crest range is 1700 meters. The XO computes the minimum quadrant elevation as follows:

a. **ANGLE a:** Select the greatest angle of site to the crest reported by the chiefs of section +16 mils.

b. **ANGLE b:** Assuming the crest is occupied by friendly troops, add the value in mils of a height of 100 meters at the piece-to-crest range of 1700 meters (100/1.7). +60 mils.

c. **ANGLE c:** Add comp site for piece-to-crest range of 1700 meters to the sum of angle a and angle b. (Column 12, table G, charge 4 GB, FT 155-AM-1, range 2000 meters gives a comp site factor of 0.010.) (16 + 60 = 76 x 0.010 = +0.760) +1 mil.

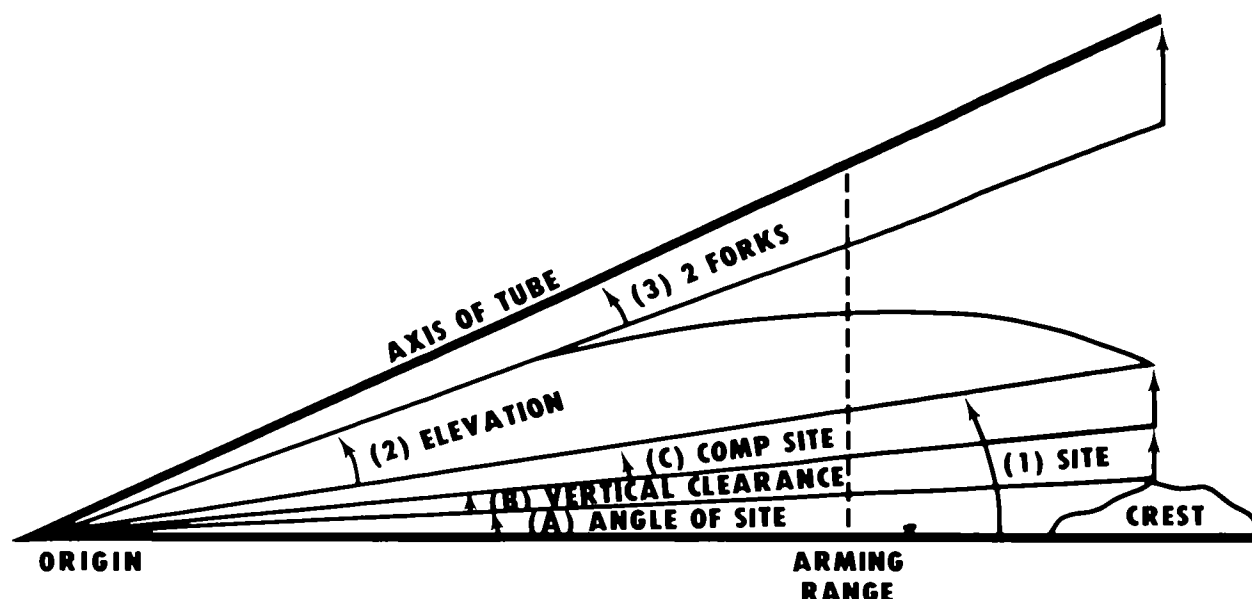


Figure 10-2. Piece-crest range greater than minimum arming range.

d. **ANGLE 1:** Determine site to crest (sum of angles a, b, and c). $(16 + 60 + 1 = +77)$ +77 mils.

e. **ANGLE 2:** Determine elevation for the piece-to-crest range. $(87.7 = 88)$ +88 mils.

f. **ANGLE 3:** Add 2 forks at the piece-to-crest range +2 mils.

g. **TOTAL:**+167 mils.

h. Minimum safe time is $5.5 + 5.5 = 11.0$
..... 11.0 seconds.

i. The XO reports to the fire direction center

**MINIMUM QUADRANT ELEVATION,
FUZE VT, CHARGE 4 GREEN BAG, 167,
MINIMUM SAFE TIME 11.0 SECONDS.**

With the 2-second arming time range, all the area between the arming range and the crest is made safe by the minimum quadrant elevation computed for the crest.

10-8. Computation of Minimum Quadrant Elevation Based on Minimum Arming Range

If the piece-to-crest range is less than the minimum arming range (fig 10-3) the XO uses the minimum arming range and the angle of site to the crest at arming range in computing the minimum quadrant elevation. Since the

XO cannot observe the terrain beyond the crest, he must assume that the angle of site at piece-to-crest range is also applicable at arming time range. He must use it in conjunction with the other factors, which are determined at arming time range, in computing the minimum quadrant elevation. After the XO determines the minimum quadrant elevation in this manner and reports it to the FDC, the battery FDC considers the need to correct the minimum quadrant elevation on the basis of the range and altitude to the highest crest not visible to the XO and short of minimum arming time range. The XO computes minimum quadrant elevations on the basis of crests visible to him or minimum arming time range. Therefore, the battery FDC must examine the best available maps to determine crests not visible to the XO. Using this information the battery FDC may compute a new minimum quadrant elevation that is different from that reported by the XO; however, the new minimum quadrant elevation can never be less than the minimum quadrant elevation for fuze M557 to the visible crest. For example—

The howitzers are 155-mm M109A1s and charge 5 green bag is to be fired. The piece-to-crest range is 500 meters, the arming time range is 800 meters, and the greatest angle of site reported is +16 mils. The XO computes the

following minimum quadrant elevation:

a. **ANGLE a:** Select the greatest angle of site to the crest reported +16 mils.

b. **ANGLE b:** Add the value in mils of a 100-meter clearance at arming time range (100/0.8) +128.

c. **ANGLE c:** Add comp site for arming time range to the sum of angle a and angle b (column 12, table G, charge 5GB, FT 155-AM-1). Since range 800 is not listed, enter at range 1,000 meters and obtain a comp site of 0.001 (16 + 128 = +144 x 0.001 = 0.144) +1 mil.

d. **ANGLE 1:** Determine site to crest (sum of angles a, b, and c, or 16 + 128 + 1 = 145). +145 mils.

e. **ANGLE 2:** Determine elevation for arming time range +31 mils.

f. **ANGLE 3:** Add 2 forks at arming time range +2 mils.

g. **TOTAL:** +178 mils.

h. Minimum safe time is $2.2 + 5.5 = 7.7$.
..... 8.0 seconds.

If the fuze setting to be fired is **EQUAL TO or GREATER THAN** the minimum safe time, the minimum QE determined for fuzes quick and time applies. If the fuze setting to be fired is **LESS THAN** the minimum safe time, the minimum QE determined for **ARMED VT** applies.

The XO reports to the fire direction center:

**MINIMUM QUADRANT ELEVATION,
FUZE VT, CHARGE 5 GREEN BAG
178, MINIMUM SAFE TIME
8.0 SECONDS.**

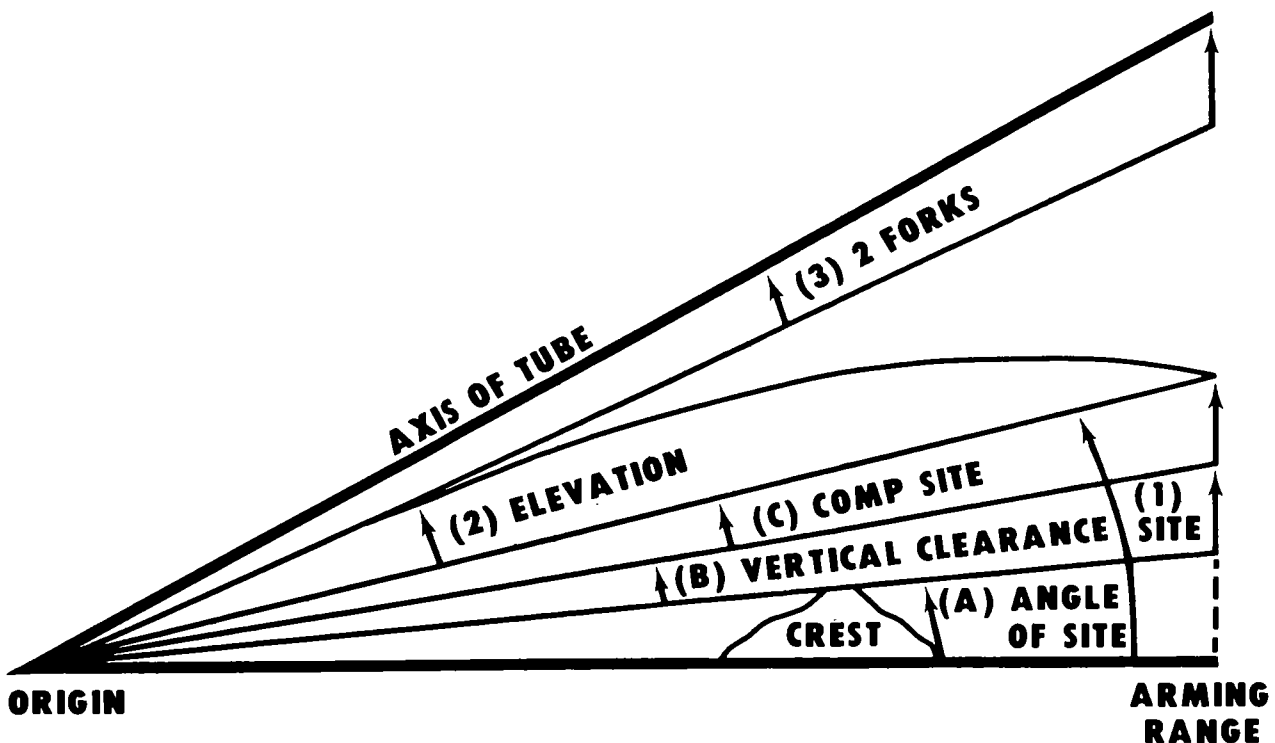


Figure 10-3. Piece-crest range less than minimum arming range.

Table 10-2 is a recapitulation of the steps for computing minimum quadrant elevation. It should be used as a reference by the XO and in

training individuals to compute minimum quadrant elevation.

Table 10-2. Computation of Minimum Quadrant Elevation

ELEMENTS OF COMPUTATION	HOW TO DO THE COMPUTATION		
	Fuze PD, fuze MTSQ, or fuze VT with a fuze setting equal to or greater than minimum safe time.	Fuze VT with a fuze setting less than minimum safe time	
		PC range is greater than minimum arming range.	Minimum arming range is greater than PC range.
Angle:			
1. Site	Sum of angles a, b, and c	Sum of angles a, b, and c	Sum of angles a, b, and c
a. Greatest angle of site reported	As reported	As reported	As reported
b. Vertical angle for clearance of friendly elements	5 meters divided by PC rg expressed up to a whole mil	Appropriate vertical clearance divided by PC range. See note.	Appropriate vertical clearance divided by MAR. See note.
c. Complementary angle of site.	Multiply the CS factor at PC rg (or next greater listed range) by the sum of angles a and b	Multiply the CS factor at PC range (or next greater listed range) by the sum of angles a and b	Multiply the CS factor at MAR (or next greater listed range) by the sum of angles a and b
2. Elevation	At PC range	At PC range	At MAR
3. 2 forks	At PC range	At PC range	At MAR
All angles above are expressed to the nearest 1 mil (always express up)	The sum of angles 1, 2, and 3 equals minimum QE.		
Reported by the XO	MINIMUM QUADRANT ELEVATION, CHARGE (so-and-so), (so many mils)	MINIMUM QUADRANT ELEVATION, FUZE VT, CHARGE (so-and-so), (so many mils)	MINIMUM QUADRANT ELEVATION, FUZE VT, AT ARMING RANGE, CHARGE (so-and-so), (so many mils)
LEGEND: PC—Piece-to-crest CS—Complementary angle of site MAR—Minimum arming range		Note: For appropriate vertical clearance see Table 10-1.	



CHAPTER 11

FIRE COMMANDS

Section I. INTRODUCTION

11-1. General

a. Fire commands give the cannon section all of the information it needs to start, conduct, and cease firing. The initial fire commands include all elements necessary for laying, loading, and firing the pieces. Subsequent fire commands include only those elements that are changed, with the exception of quadrant elevation, which is *always* announced.

b. Normally, fire commands come from the fire direction center or the BOC. The FDC (or BOC) receives fire missions and converts mission information into fire commands. The fire commands are sent to the cannon sections by the best available means of communications. Firing battery supervisors

must insure that the FDC and cannon sections understand and use the fire commands prescribed in this manual. It is imperative that all elements of the gunnery team (FIST, FDC, and firing sections) make every effort to be responsive to the needs of the supported elements. Streamlined calls for fire, FDC procedures, and fire commands have enhanced responsiveness, but in order to achieve the desired results, each individual must understand these procedures.

c. Since numbers make up a large portion of all commands received or given in the firing battery, they must be announced in a clear, precise manner, with snap—like a *command*—and in a voice loud enough to be properly understood. Numbers are pronounced as follows:

NUMBER	PRONOUNCED AS
0	Ze-ro
1	Wun
2	Too
3	Tree
4	Fow-er
5	Fife
6	Six
7	Sev-en
8	Ait
9	Nin-er
44	Fow-er fow-er
80	Ait ze-ro
100.7	Wun ze-ro ze-ro point sev-en
136	Wun tree six
500	Fife hun-dred
1478	Wun Fow-er Sev-en ait
3200	Tree too hun-dred
7000	Sev-en tou-sand
16,000	Wun six tou-sand

11-2. Sequence of Fire Commands

a. Fire commands are announced to a firing battery in the following sequence:

SEQUENCE Element	WHEN ANNOUNCED	
	Initial fire commands	Subsequent fire commands
1. Warning order	Always	Never
2. Pieces to follow/ pieces to fire/* method of fire*	Always	When applicable
3. Special instructions • Do not load • At my command • By piece at my command • High angle • Use gunner's quadrant • Azimuth • Special corrections • Primary (left right) sector • Cancel terrain corrections	When applicable	When applicable
4. Projectile*	When other than standard	When changed

*These elements may be designated as standard. Elements so designated will be announced only when something other than standard is to be fired.

SEQUENCE Element	WHEN ANNOUNCED	
	Initial fire commands	Subsequent fire commands
5. Ammunition lot *	When other than standard	When changed
6. Charge	Always	When changed
7. Fuze/fuze setting*	When other than standard	When changed
8. Direction	Always	When changed
9. Quadrant elevation	Always	Always
10. Method of fire for effect	When applicable	When changed

b. Fire commands are given to the cannon sections in a prescribed sequence to—

(1) *Save time.* Issuing fire commands in the proper sequence allows time for the commands to be announced as rapidly as they can be understood and complied with by the personnel of the firing battery and also prevents the omission of an element of data. A prescribed sequence allows several operations to be executed simultaneously. For example, first the sections are alerted, and then the data pertaining to ammunition are given, followed by the deflection and quadrant elevation. This sequence allows the ammunition to be prepared for loading while the piece is being laid for direction and quadrant elevation.

(2) *Eliminate errors.* Each member of the cannon section *must* know the meaning of each element of the fire commands and the sequence in which the elements are announced. Each crewman can then distinguish the numerical portion of one element from that of another element and can be on the alert for the element(s) pertaining to his duties.

round being fired are inspected and excess increments are removed.

11-9. Fuze/Fuze Setting

The type of *fuze* to be used is announced in the initial fire commands only when it is other than the designated standard. It is announced as a subsequent command only when a change is desired. When VT or time fuzes are fired, this element includes the *fuze setting*; e.g.,

FUZE VT, 59.0

11-10. Direction

Direction is always announced as a *four-digit deflection*; e.g.,

DEFLECTION 3218

The gunner sets the commanded deflection on his panoramic telescope and traverses the tube until he is sighted on the proper aiming point.

11-11. Quadrant Elevation

a. Quadrant elevation is announced in initial and subsequent fire commands. *The command QUADRANT (so much) is permission for the chief of section to load and fire the round unless otherwise restricted by special instructions.*

b. To increase responsiveness, a unit may adopt certain alternate loading procedures as SOP. These include:

(1) *Loading on deflection.* This procedure is especially effective in towed units, where loading may not interfere with receipt of the remaining fire commands.

(2) *Adjusting piece(s) loading subsequent rounds immediately after firing.* This loading method can be used for all projectile/fuze combinations not using a mechanical time fuze. If this procedure is used, it is possible that the adjusting piece may not have the correct projectile/fuze combination loaded when entering FFE. If this occurs, the loaded round will be fired and the remaining FFE rounds will be fired using the correct projectile/fuze combination. At the end of the mission, the chief of section will

report to the FDC that his piece fired ammunition not specified in the fire command. For example, the fire command is 3 ROUNDS VT IN EFFECT. Piece number 4 fired one round without fuze quick and two rounds with fuze VT. The chief of section reports

*NUMBER 4 FIRED 1 QUICK
AND 2 VT IN EFFECT.*

The FDC will make an appropriate correction to the ammunition count. If the FDO decides to terminate automatic reload, he will administratively inform the firing sections prior to announcing quadrant. For example—

*NUMBER 4, CANCEL
AUTOMATIC RELOAD,
QUADRANT 314.*

(3) *Nonadjusting pieces loading the shell to be fired in effect upon receipt of the initial fire commands.* This procedure also applies to all projectile/fuze combinations not using a mechanical time fuze. When the FFE fuze is fuze VT, the FDC calculates the VT fuze setting corresponding to the initial target location and sends it to the nonadjusting pieces. If terrain, weather, and enemy capabilities permit, the FDC can send the VT minimum safe time to the nonadjusting pieces.

c. The decision to use one or more of these alternate loading techniques is made by the commander and is influenced by the state of training of the FDC and cannon sections.

CAUTION: DO NOT LOAD ROUNDS INTO HOT TUBES UNLESS IT IS CERTAIN THEY WILL BE FIRED WITHIN 5 MINUTES.
--

11-12. Method of Fire for Effect

This element indicates the number of rounds and type of ammunition to be used in effect, when applicable. It is announced after the quadrant in adjust fire missions so as not to delay the firing of initial data. **EXAMPLE:** If the initial commands include BATTERY

ADJUST, the method of fire for effect might be

2 ROUNDS IN EFFECT.

11-13. Special Methods of Fire

a. *ZONE FIRE.* This method of fire is used when the standard sheaf does not adequately cover the target and more depth is required. The number of mils to the zone and the number of quadrants to be fired will be announced by FDC. For example, upon receipt of the command

*ZONE 5 MILS,
5 QUADRANTS*

each chief of section computes the required quadrants and then fires them after the initial quadrant announced in the fire command. If, in this example, the announced quadrant were 310, it would be fired first; the remaining quadrants would be 320, 315, 305, and 300, fired in any order. Note that there will always be an odd number of quadrants.

b. *SWEEPING FIRE.* This method of fire is similar to zone fire but provides for firing several deflections with one quadrant. For example,

*SWEEP 10 MILS,
3 DEFLECTIONS.*

As in zone fire, each chief of section computes the required deflections and fires them after the initial deflection has been fired. For example, if the announced deflection is 3220, it would be fired first; the remaining deflections would be 3230 and 3210 and would be fired in any order. Again, there will be an odd number of deflections to be fired.

c. *SWEEP AND ZONE.* This method of fire combines zone fire and sweeping fire. The chief of section will first fire the announced deflection and quadrant and then fire all

combinations of the computed deflections and quadrants. For example,

*SWEEP 10 MILS, 3 DEFLECTIONS,
ZONE 4 MILS, 3 QUADRANTS.*

If the announced deflection is 3200 and the announced quadrant is 310, the three deflections to be fired would be 3200, 3210, and 3190 and the three quadrants to be fired would be 310, 306, and 314. Each quadrant would be fired with each deflection (total of nine rounds). Deflection 3200 and quadrant 310 would be fired first.

d. *CONTINUOUS FIRE.* When it is desired to fire continuously at a target, the command is

CONTINUOUS FIRE.

At this command, the sections load and fire as rapidly as possible consistent with accuracy and within the prescribed rates of fire for the pieces. The crews continue to fire until commanded to

CHECK FIRING

or

CEASE LOADING.

e. *FIRE AT WILL.* If the method of fire is for pieces to fire at will, the command is

*TARGET (so-and-so),
FIRE AT WILL.*

If a method of close defense has been prearranged, the command is simply—

FIRE AT WILL.

At this command, the designated piece or pieces fire under the control of the chief(s) of section as the situation and target necessitate.

Section III. USE OF FIRE COMMANDS

11-14. Standardizing Elements of the Fire Command

a. Certain elements of fire commands may be standardized after consideration of the tactical situation, weapon and personnel capabilities, ammunition status, and enemy counterfire threat. As shown in paragraph 11-2, the following elements of the fire command may be designated as standard: *pieces to fire/method of fire, projectile, ammunition lot, and fuze*. If the FDO decides to vary from fire command standard data, he must administratively cancel the existing standard and issue the replacement standard data. Only one set of standard data can be in effect at any particular time. Once placed in effect, the battery will fire the standard data unless the fire command specifies something different.

b. Example: The FDO considers the tactical situation and the other factors mentioned above and determines that the fire command elements designated as standard should be:

(1) Pieces to fire/method of fire: Number 3, one round (number 3 will be the adjusting piece and will fire one round in adjustment).

(2) Projectile: HE.

(3) Ammunition lot: XY.

(4) Fuze: Q.

These standards inform the firing battery that during an adjust fire mission, number 3 will adjust and each time will fire one round, shell HE, lot XY, and fuze quick. After firing each round, number 3 can then load another standard round in preparation for the subsequent fire commands. The use of fire command standard data and immediate reloading (if desired) will greatly increase responsiveness.

11-15. Examples of Fire Commands

a. *Standard adjust fire mission.* Elements designated as standard in this example are number 3 firing one round in adjustment, shell HE, lot XY, and fuze quick.

Note. Each section should keep a minimum of six rounds of a designated standard lot of ammunition prepared and ready to fire at all times.

**FIRE MISSION, BATTERY ADJUST,
CHARGE 6, DEFLECTION 2938, QUAD-
RANT 200, 2 ROUNDS IN EFFECT.**

(1) Number 3 fires one round of shell HE lot XY, fuze quick, at the announced deflection and quadrant, and then reloads.

(2) The first subsequent fire commands in this example are:

DEFLECTION 2978, QUADRANT 218.

Number 3 fires the new deflection and quadrant and reloads.

(3) The second subsequent fire commands in this example are:

**BATTERY 2 ROUNDS, DEFLECTION
2950, QUADRANT 210.**

The entire battery fires two rounds at the announced quadrant and deflection.

END OF MISSION

is commanded as appropriate.

b. *Nonstandard adjust fire mission.* Elements designated as the standard in this example are number 3, one round, shell HE, lot XY, and fuze quick.

**FIRE MISSION, BATTERY ADJUST,
NUMBER 4, 1 ROUND, CHARGE 4,
DEFLECTION 3024, QUADRANT 447,
2 ROUNDS ICM IN EFFECT.**

(1) Number 4 is announced as the adjusting weapon and fires one round, shell HE, lot XY, fuze quick at the announced charge, deflection, and quadrant. The remainder of the battery prepares two rounds of ICM and follows the fire mission. The adjustment continues as in the first example.

When fire for effect is entered, the commands are:

**BATTERY 2 ROUNDS, SHELL ICM,
FUZE TIME 24.2, DEFLECTION 3008,
QUADRANT 443.**

(2) The entire battery fires two rounds of shell ICM at the announced time, deflection, and quadrant.

END OF MISSION

is commanded as appropriate.

c. Standard fire-for-effect mission. Elements designated as standard in this example are number 3, one round, shell HE, lot XY, and fuze quick.

**FIRE MISSION, BATTERY 2
ROUNDS, CHARGE 4, DEFLECTION
3377, QUADRANT 487.**

Each weapon in the battery fires two rounds of the standard shell, lot, and fuze at the announced deflection and quadrant.

d. Nonstandard fire-for-effect mission. In this example, no standard elements are used.

**FIRE MISSION, NUMBER 2, 3, 4, AND
5, 3 ROUNDS, AT MY COMMAND,
SHELL WP, LOT TZ, CHARGE 7,
FUZE QUICK, DEFLECTION 2870,
QUADRANT 320.**

Numbers 2, 3, 4, and 5 each fire three rounds of the announced shell and lot, charge 7, and fuze quick at the announced deflection and quadrant. Since the special instruction AT MY COMMAND was announced, the section chiefs report READY and wait to fire until given permission to fire by FDC.

11-16. Check Firing/Cease Loading

a. Normally, the command

CHECK FIRING

is given by the FDC, but it may be given by anyone present. On this command, regardless of its source, firing will cease

immediately. The signal for CHECK FIRING is to raise the hand in front of the forehead, palm to the front, and swing the hand and forearm up and down in front of the face. Another signal for CHECK FIRING is one long blast on a whistle. Firing is resumed at the announcement of CANCEL CHECK FIRING and the quadrant elevation.

b. The command

CEASE LOADING

is similar to CHECK FIRING. Upon receipt of this command, the cannoneers may fire the weapons that are already loaded, but no additional rounds may be chambered. Firing is resumed at the announcement of

CANCEL CEASE LOADING

and the quadrant elevation.

11-17. End of Mission

The command

END OF MISSION

means that the fire mission has been completed. All corrections applied to the fire control equipment for that mission are to be removed. Primary terrain gun position corrections are to remain on the appropriate counters unless commanded otherwise by the fire direction center. If a priority target has been assigned, each section will lay on the appropriate firing data.

Note. The assigned targets may not always be located in the primary sector, so the applicable position corrections (primary, left, right) must be applied to the counters prior to setting off and laying on assigned target data.

11-18. Repetition of Commands by Chief of Section

a. By voice communications. Chiefs of section repeat the commands FIRE, CHECK FIRING, and CEASE LOADING. Any other fire commands are repeated only when requested or when they obviously have not been heard or understood. The request for

repetition is stated as a question; e.g.,

DEFLECTION NUMBER
(so-and-so)?

b. *By intrabattery communications.* When radio or wire communications are used between the FDC and the individual sections, the readback of elements of the fire commands is governed by unit SOP. One piece should be designated to read back all fire commands. If the howitzer loudspeakers are not working, the person designated by the chief of section to operate the radio or telephone must announce each element of the fire command to the section.

c. *By FDC.* The repetition of commands by the FDC is always preceded by THE COMMAND WAS; e.g.,

THE COMMAND WAS
DEFLECTION 2768.

11-19. Planned Targets

a. At times the battery will be assigned planned targets, which must be fired quickly. One of these will be designated by the FDC as the priority target, and each weapon will be laid on its assigned priority target when not actively engaged in a mission. Appropriate

ammunition will be kept on hand and personnel at the piece will begin firing the weapon as soon as a command is received.

b. One common type of priority target is the final protective fire (FPF). To order the FPF to be fired, the command

FIRE THE FPF

or a prearranged signal is given.

c. In offensive operations, suppressive fires are frequently delivered by the battery. Some of these may be planned fires; if so, each section maintains firing data on these targets as directed by the FDC. These targets are recorded at the section as follows:

In this case the sections in the platoon would lay on target 43. The command from FDC to fire would be

(so-and-so) **SUPPRESS,**

followed by the target number; e.g.,

RIGHT SUPPRESS 43.

If target 54 or 57 is to be fired, the command would be

RIGHT SUPPRESS 54,

which means the platoon would relay and fire the data for target 54.

PRIORITY TARGETS									
TGT NO.	SP INST	RDS	SH	LOT	CHG	FZ	TI	DF	QE
43	—	2	HE	XY	6	Q	—	3210	402
54	—	2	HE	XY	6	VT	29.0	3190	418
57	—	4	SMK	TY	6	TI	31.2	3182	432

11-20. Reports

The section chief reports to the FDC all actions that affect the firing of his weapon in support of the battery mission. In the conduct of firing the following *specific* reports are made:

a. *SHOT NUMBER (so-and-so)* after each round of a fire mission has been fired. If a round or fuze *other* than the one announced by the FDC is fired, it *must* be reported to the FDC.

b. *ROUNDS COMPLETE NUMBER (so-and-so)* when the final round of fire for effect (other than one round) has been fired.

c. *MISFIRE NUMBER (so-and-so)* when there has been a misfire. The chief of section reports *NUMBER (so-and-so) IS READY* when the piece is ready to fire.

d. *NUMBER (so-and-so) IS OUT (reason)* when a piece has been called out of action.

e. *Number of rounds expended by type and lot number (when required)*.

f. Chiefs of section must tell the FDC if any round has been fired with improper data. The chief of section will report the actual data fired in error, e.g.,

*NUMBER 2 FIRED
DEFLECTION (so much).*

The executive officer has the error(s) corrected and reports to the battalion FDC, e.g.,

*NUMBER 2 FIRED
20 MILS RIGHT.*

11-21. Correcting Fire Commands

a. If an incorrect command has been given but the command *QUADRANT* has *not* been announced, the FDC commands

CORRECTION

and then gives the correct command and all subsequent elements.

b. If *QUADRANT* has been announced, the FDC commands

CHECK FIRING.

Then

CANCEL CHECK FIRING

is announced, followed by the proper element and all subsequent elements.

11-22. Miscellaneous Commands

a. *Special corrections.* In addition to the special corrections indicated in paragraph 11-5, other special corrections may be announced administratively; e.g., position corrections or instructions to open or close the sheaf for a particular mission. The commands are:

*SPECIAL CORRECTION,
NUMBER (so-and-so),
LEFT 7.*

This command may be given administratively, apart from fire commands, or may be announced in the *SPECIAL INSTRUCTIONS* element of fire commands.

*SPECIAL CORRECTIONS, ON
BASE PIECE
(or NUMBER so and so),
OPEN (CLOSE) (so many).*

In this example, each piece other than the base piece applies a correction to the announced deflection by placing the correction on the gunner's aid. Each gunner determines his correction by multiplying the correction announced in the command by the number of pieces his piece is removed from the one on which the sheaf is to opened or closed. For example, the command

*ON NUMBER 3,
CLOSE 4*

is given. Number 3 fires the announced deflection. Number 1 applies left 8; number 2, left 4; number 4, right 4; number 5, right 8; and number 6, right 12. These corrections are applied to any position corrections already on the gunner's aid, and remain in effect until the command *END OF MISSION* is given.

CHAPTER 12

SPECIAL SITUATIONS

Section I. ASSAULT FIRE

12-1. General

a. Assault fire is a special technique of indirect fire. Fire is conducted at a relatively short range to obtain pinpoint accuracy against a stationary target (e.g., bunkers or caves). The gun-target range is sufficiently short to make possible successive hits on the same portions of the target. Only one piece is used on a mission, and the fire direction center (FDC) or BOC is located at the cannon position. Thorough planning, reconnaissance, and coordination must be completed before the position is occupied. Since field artillery is at a premium, this technique should be considered *only* after maneuver force weapons, such as tanks, have failed, or because terrain prohibits their use.

b. Any field artillery cannon can be used for assault fire; however, any caliber smaller than 155-mm is considered impractical. The most efficient weapons, in order of preference, are the 8-inch howitzer, the 155-mm howitzer and the 175-mm gun. Self-propelled weapons are best suited for this task because of their maneuverability and ease and speed of emplacement and displacement. When the maximum charge is used, maximum effective assault fire ranges are 3000 meters for the 8-inch howitzer and 2500 meters for the 155-mm howitzer and the 175-mm gun.

12-2. Assault Fire Procedures

a. Normal fire direction procedures and fire commands are used; however, in order that the small deflection changes that are necessary in assault fire can be made, a special technique of laying is employed at the piece.

b. Deflection changes are made to the nearest mil until a 1-mil deflection bracket has been obtained; further changes are made to the nearest one-fourth mil. *One-fourth mil can be set on weapons equipped with the*

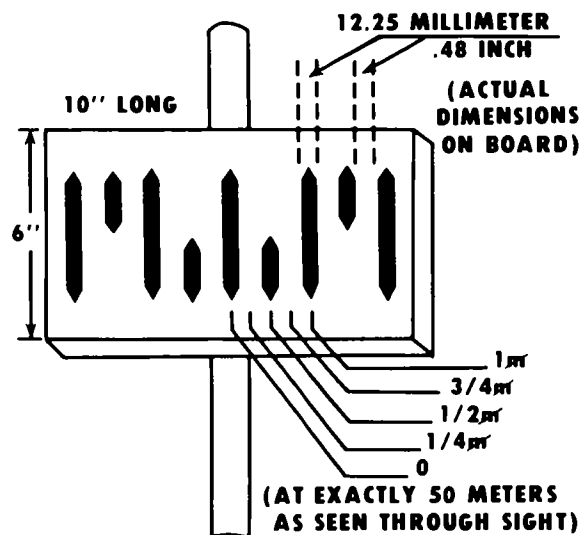


Figure 12-1. Deflection board.

M100-series sights. For weapons with M12-series sights, a deflection board (which must be locally fabricated) attached to an aiming post (fig 12-1) enables the gunner to make

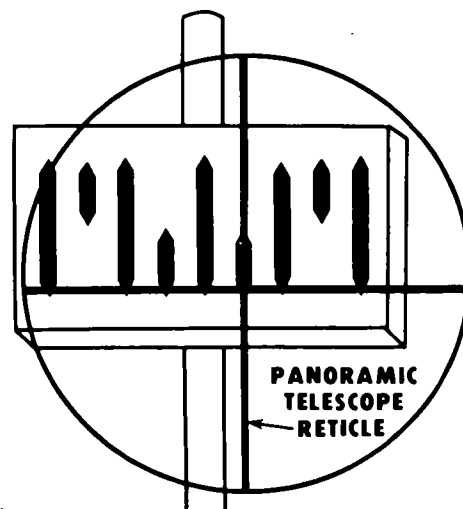


Figure 12-2. Gunner's sight picture.

deflection changes to one-fourth mil. The black and white bands (lines) are one-fourth mil in width when viewed through the sight of the piece at a distance of exactly 50 meters.

c. One board per howitzer is required. The gunner lays on the desired portion of the board by centering the vertical crosshair of the sight on a black (white) band on the board. To move one-fourth mil, he moves the line of sight by traversing the piece in the

proper direction so that the adjacent white (black) band is covered; to move one-half mil he moves the vertical crosshair until the second band is covered, etc. Figure 12-1 shows the sight picture when deflection is moved to the right by one-half mil. For changes in elevation to the nearest 0.1 mil, the gunner's quadrant is used.

d. For adjustment and fire direction procedures, see FM 6-40.

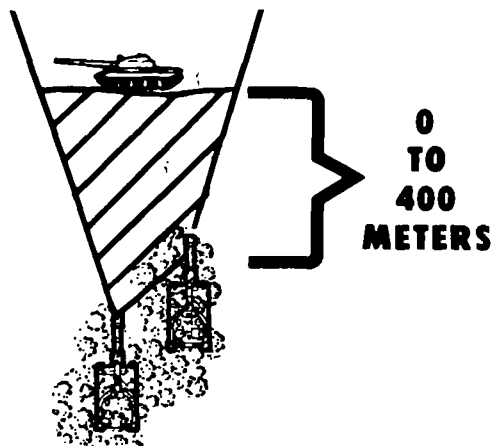
Section II. DIRECT FIRE

12-3. General

a. Direct fire is a special technique that demands a high standard of training. The section must operate as an independent unit. Enemy targets taken under fire by direct fire procedures are usually those capable of returning direct fire; therefore, speed and accuracy are of the utmost importance. The commander *must* bear in mind that direct fire is used as a *last resort only*, after the location of the battery has been detected by an enemy force *and* that force has launched an attack.

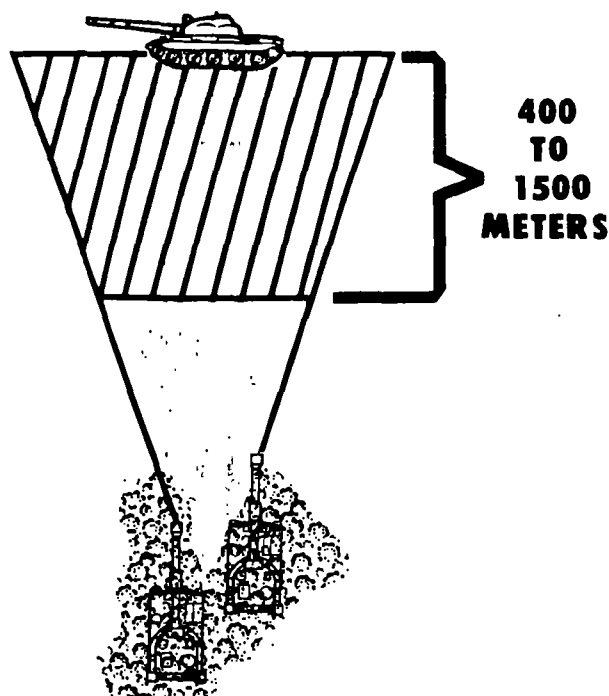
b. The trajectory of the weapon involved, types of targets, and the types of ammunition and fuzes to be employed against various targets must be considered by the XO. The maximum charge should always be used for direct fire. Here are some considerations for trajectory, types of targets, and ammunition.

(1) Trajectory. Trajectory characteristics change with the type of ammunition and the charge fired. The following information is based on use of charge 7.



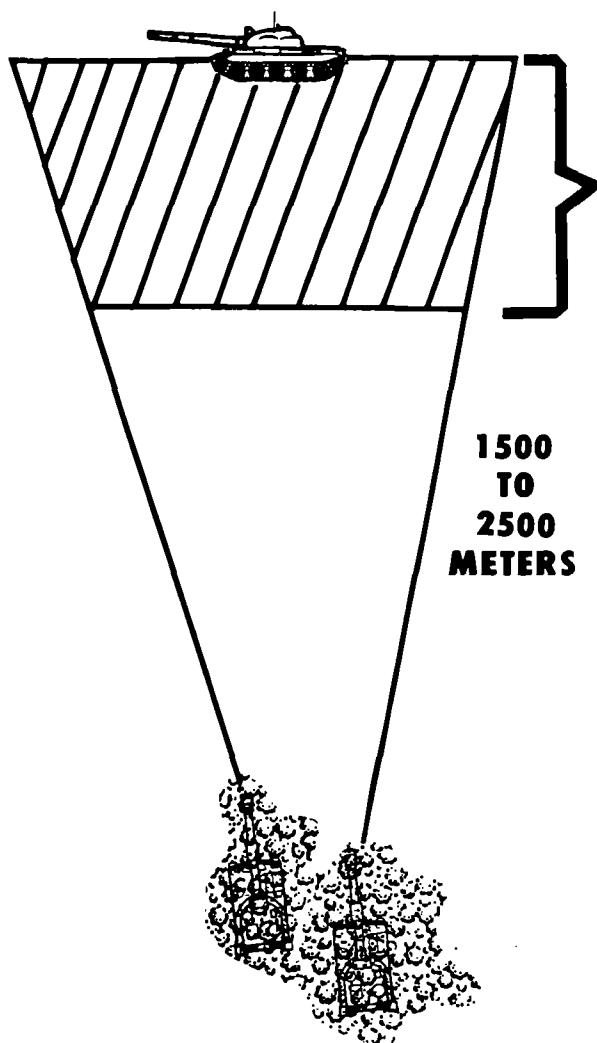
(a) 0-400 meters. Within this range the trajectory will be flat enough to prevent an 8-foot tank from passing safely under it. The optimum range at which to engage a target with direct fire is 400 meters. Terrain allowing, targets should be engaged at as close to 400 meters as possible.

(b) 400-1,500 meters. In this zone the trajectory is flat enough to allow direct estimation of range without actual bracketing of the target. Assuming little dispersion, if you obtain a hit at the bottom of an 8-foot tank when firing at 1500 meters, a 100-meter increase in range will give you a round that will just brush the top of the tank.



If adjusting within this zone, range changes of more than 100 meters should *not* be made. Usually, range changes in 50-meter increments will give the best results. The upper limit (1500 meters) of this zone is considered the maximum range at which a target should be engaged except in unusual situations. Within this zone, a well-trained crew should require no more than two shots to obtain a hit.

(c) 1500-2500 meters. Hits are only reasonably possible in this zone, and the bracket method of adjusting will probably be required to obtain a hit. Do not engage a target at these ranges unless absolutely necessary.



(d) Over 2500 meters. In this zone direct laying is not advised, as a *hit on a*

moving target, even with accurate bracketing and range estimation is very unlikely.

(2) Types of targets. The most likely direct fire targets are vehicles, tanks, and/or dismounted personnel that are threatening the battery. Enemy personnel, alone or with tanks, will not usually present themselves as clearly defined targets. In this case, fire should be delivered in the area containing the attackers rather than on the individuals. Tanks usually attack in groups and may be accompanied by infantry. Priority within a given sector of direct fire should be given to—

(a) Tanks at short ranges threatening to overrun the position.

(b) Hull-down stationary tanks covering the advance of other tanks.

(c) The commander's tank, if identified.

(d) Tank(s) nearest to cover.

(3) Ammunition and fuzes.

(a) Ammunition. Against armor and vehicles.

Antitank ammunition, high-explosive, plastic-tracer (HEP-T), available for 105-mm only, is best.

The high-explosive shell is effective against armor and vehicles, but you must attempt to hit a vulnerable portion of a tank (e.g., side view, the track or road wheels; front view, between the carriage and the turret).

Smoke shells (HC or WP) can be used very effectively to obstruct the vision of tank gunners.

The white phosphorus shell is excellent for setting immobilized tanks and vehicles on fire.

(b) Ammunition against personnel.

The beehive antipersonnel round (105-mm only) is very effective.

The high explosive shell with VT or mechanical time fuze is lethal against unprotected troops, can separate infantry from tanks, and effectively causes the tank crews to "button-up."

(c) Fuzes.

When the HE round is fired against tanks or vehicles, the impact fuze should be used in the superquick mode.

Against personnel, the impact fuze in the delay mode may cause an effective ricochet effect. When the delay mode is used, the point of impact must be adjusted 10 to 30 meters in front of the target. If the ground is such that less than half the shells can be expected to ricochet, the superquick mode should be used.

As mentioned above, proximity and mechanical time fuzes can be used with the HE shell against personnel; however, the mechanical time fuze will generally give erratic results.

12-4. Sighting

There are three primary methods of sighting used in direct fire:

a. Two-man, two-sight. This method is *best* for all weapons *except* the 155-mm howitzer M114A1. The gunner establishes lead with the panoramic telescope and the assistant gunner establishes elevation with the direct fire telescope. This is the fastest and most accurate method of sighting and permits the assistant gunner to check the direction of lead. The reticle in the direct fire telescope *must* be level. A canted reticle in the direct fire telescope will prevent satisfactory direct fire on moving targets because an unacceptable range error is introduced when lead is changed.

b. Two-man, one-sight. This method is *best* for the M114A1. The gunner establishes lead with the panoramic telescope and the assistant gunner sets elevation on the elevation quadrant at the command of the chief of section. This method is *not* effective when the target is moving on other than flat terrain.

c. One-man, one-sight. This method is *least desirable* and should *not* be used unless absolutely necessary. The gunner lays for lead and elevation with the reticle of the panoramic telescope. This method should *not* be used if the target is moving on a steep slope.

12-5. Laying

There are two primary methods of laying:

a. Reticle laying with deflection zero. This method is *best for the M12-series sights*. The gunner maintains lead by placing the vertical hairline the proper number of mils ahead of the point of aim on the target (fig 12-3).

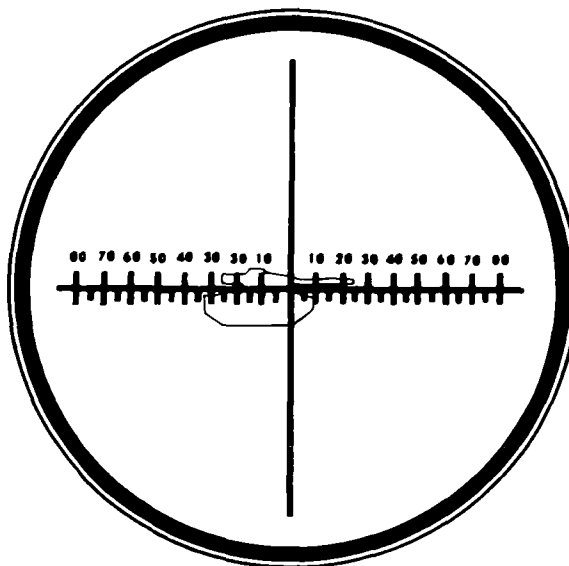


Figure 12-3. Gunner's sight picture, reticle laying, lead right 10 mils.

b. Central laying. This method is *best for M100-series sights*. The gunner sets the lead in mils on the azimuth micrometer scale of the panoramic telescope and maintains the vertical hairline of the reticle on the center of the target (fig 12-4). A modification on the knob of the M100-series panoramic telescope, called click sights, permits the gunner to set off lead in 5-mil increments, by sound or feel, without removing his eye from the sight.

12-6. Commands

a. Commands for direct fire are normally given by the howitzer section chief. The commands include—

- (1) A warning order—TARGET (so-and-so).
- (2) General direction to the target—LEFT FRONT.
- (3) Lead in mils (how to determine lead is

CHAPTER 13

COMMUNICATIONS

13-1. Introduction

a. In our ability to communicate on the battlefield, we face two obstacles—frequent moves and the enemy's sophisticated electronic warfare capability. Communications systems must be oriented toward overcoming these obstacles.

b. The cannon battery has available to it two major communications systems—the *radio system* and the *wire system*. Initially, radio is the primary system; however, as soon as the wire system is installed, it becomes primary. Each has different capabilities, vulnerabilities, and limitations and each must be employed to complement the other.

c. Frequent moves will almost certainly increase the battery's reliance on radio communications. Unfortunately, the enemy is equipped and trained to employ electronic warfare effectively. If the enemy jams a battery's radio communications, he has probably reduced the effectiveness of that battery.

d. Another aspect of the enemy's electronic warfare capability is his use of radio direction-finding equipment, which indicates the position of transmitting radios. A longwinded radio operator may well find enemy artillery pouring in on his position within minutes. The most effective way to combat this threat is the use of STRICT COMMUNICATIONS DISCIPLINE. Units must be able to march under absolute radio listening silence. Fire nets must remain unused until needed for support of the maneuver element. The commander can counteract the enemy's electronic warfare capability by enforcing wise, disciplined utilization of all the communications assets available to him. This cannot be accomplished without a thorough training program—not just for the communications section, but for all the people in the battery who use communications equipment. Some tips for the conduct of this training are in the latter part of this chapter.

e. Also, see TC 6-10-1, *Field Artillery Communications*, for an excellent complementary discussion of battlefield communications at battery and battalion levels.

13-2. The Battery Radio System

a. The cannon battery operates radios in the battalion command/fire direction nets (CF1 and CF2) as directed by battalion headquarters. When the small unit transceiver (SUT) the AN/PRC-68, is issued, the battery also will operate a battery command (CMD) net (see para 13-9). Additional requirements may be as follows:

(1) The battery in a direct support battalion may operate in one of three fire direction nets (F1, F2, F3). Normally, these nets are assigned one per cannon battery. Principles of operating the FD nets are—

(a) Expose FD nets only on *demand* of the FIST or as directed by the battalion FDC.

(b) *Never* use the FD net for administrative traffic.

(2) When operating in a dedicated role, the battery will monitor the command net of the maneuver company/team receiving dedicated support.

(3) Normally, general support, general support-reinforcing, and reinforcing units operate in only one FD net, but it is conceivable that a reinforcing or GSR battalion could be given the task of dedicating one of its batteries to a maneuver unit. That battery's communications requirements would be the same as those of the direct support unit in the dedicated role.

b. The wire communications requirements for the FDC and BOC are discussed in paragraph 13-5. The optimum battery radio system is shown in figure 13-1. For maximum

flexibility, all cannon units should try to distribute their radios in this manner. The BOC should have one VRC-47 installed, and the battery commander's VRC-47 should be remoted into it when his vehicle is in the area.

c. In those units that do not have sufficient radios to provide three nets in both locations, the following setup will allow the FDC adequate communications:

(1) The two VRC-46 radios should be located in the FDC.

(2) The VRC-47 should be located in the BOC and remoted into the FDC for monitoring the maneuver net when necessary.

13-3. Radio Communications Discipline

Communications discipline must be an item of command concern. It should be integrated into all training and emphasized over and over. The following are some ways to enhance communications discipline:

a. Thorough SOPs and use of both the operating and brevity codes contained in the CEOIs can substantially reduce the number and length of required radio transmissions.

b. Runners should be utilized whenever feasible.

c. Lengthy radio transmissions must be forbidden.

d. Operators must resist the temptation to make frequent radio checks.

e. Low power settings should be used whenever possible.

f. Reports and statistical updates should be closely examined. Only those absolutely necessary should be sent by radio.

g. The battery should habitually displace under radio listening silence. This requires command emphasis and training. It will become even more difficult when the cannon sections are provided radios.

Table 13-1. Radio Operator Performance Objectives

1. Install a radio and begin operation.
2. Troubleshoot communications equipment when failures occur.
3. Erect the RC-292 antenna, assemble it properly for a particular frequency, and disassemble it (BOC and FDC personnel only).
4. Perform operator-level maintenance on a radio.
5. Remote a radio set (FDC and BOC personnel and BC's driver).
6. Know the structure of the unit's radio net.
7. Use the CEOI, unit SOP, and authorized codes.
8. Use correct radio transmission procedures.
9. Identify enemy jamming and imitative communications actions and take proper countermeasures.
10. Set up, install, and operate electronic speech security equipment, to include use of the code changer key.
11. Site radio antennas for effective communications and safety.

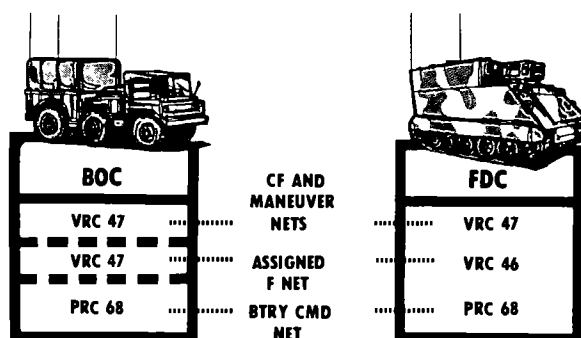


Figure 13-1. Cannon battery radio communications.

13-4. Tips for Training Radio Operators

The battery communications system is only as good as its operators. The following

guidelines are offered as an approach to developing an effective training program for radio operators. A list of specific performance objectives for radio operators is in table 13-1.

a. Identify the principal radio operators and backup operators. This group will include *anyone*, regardless of MOS or grade, who will normally operate a radio set.

b. Radio operators should be trained weekly, as a minimum. This drill should exercise as many of the skills indicated in table 13-1 as possible. Much realism can be integrated into the training if actual battery radio transmissions on field exercises, CPXs, etc. are recorded and then used in developing a drill format.

c. The drill sessions should be recorded, if possible. This allows the operator to hear himself and identify his own weaknesses.

d. Putting up the RC-292 antenna and trimming it properly takes a lot of practice. The FDC and BOC personnel should be drilled regularly in this task and should strive for a time of 5 minutes or less.

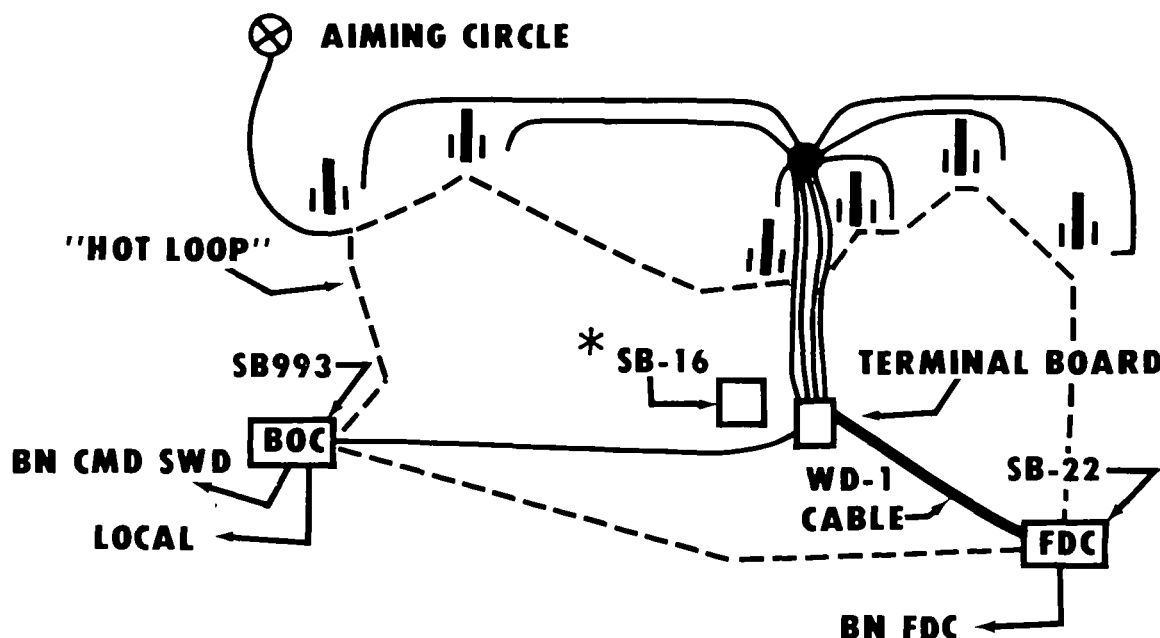
e. Training should also include taking the antenna down to change frequencies once it has been erected.

f. Commanders should insure that the antenna is habitually erected and that personnel are as proficient at this task during darkness as they are during daylight.

13-5. The Battery Wire System

a. Ordinarily, all the wire teams will be consolidated under the control of the battalion communications platoon. This system allows a vehicle for each wire team and speeds up the establishment of wire communications between the battery and the battalion headquarters. It is the responsibility of the battalion wire team, then, to furnish both command and fire direction circuits to each battery.

b. Cannon battery personnel within those sections that use wire communications (FDC, BOC, howitzers, etc.) must be trained to establish, protect, and repair the intrabattery wire communications system. A suggested system is shown in figure 13-2.



*** NOTE - SB-16 IS USED TO LAY THE BATTERY INITIALLY**

Figure 13-2. Intrabattery communications.

c. In this system, the SB-16 (MX-155) is set up initially (preferably by the advance party) to lay the battery. Each cannon lays a line to it. Wire lines from the DR-8s at the sections are routed around a stake in front of the line of metal to insure that they are not torn up by local traffic in the area. The XO plugs a line from the aiming circle into the DR-8 of the nearest cannon. Using wire, he then lays the battery. This allows the drivers to observe the proper engine shutdown procedures without disturbing the laying process.

d. The terminal board (fig 13-3) is set up next to the SB-16 by the XO's driver or someone in the FDC. The wire lines (which must be tagged or colorcoded) that are plugged into the SB-16 for laying the battery are easily transferred to the terminal board.

e. The FDC has a preassembled cable of seven pairs of WD-1 attached to the TM-184 portion of the terminal board. Ordinarily, these wires can remain hooked up during movement. The other end of the cable is attached to the FDC SB-22 switchboard.

f. The BOC also lays one line to the terminal board. All lines should be buried or overheaded as soon as possible for protection. Once all wire lines have been transferred to the terminal board, the SB-16 is taken up to be used again by the advance party.

g. The terminal board, which must be fabricated locally by using units, is essential for efficient simultaneous handling of

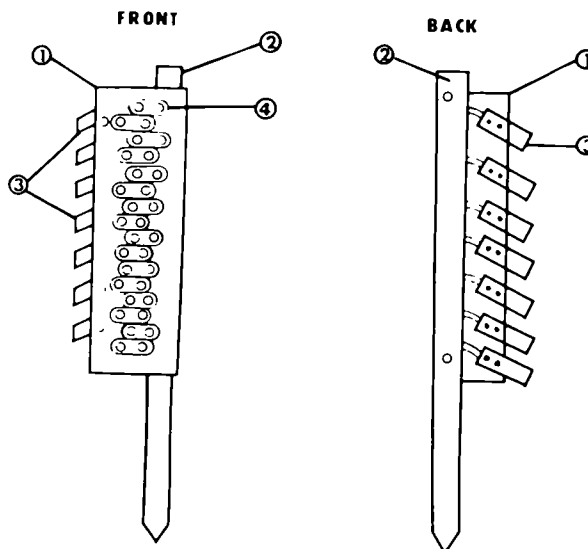
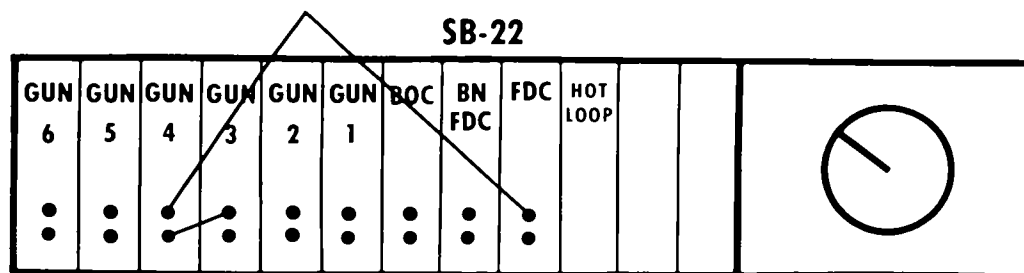


Figure 13-3. Terminal board.

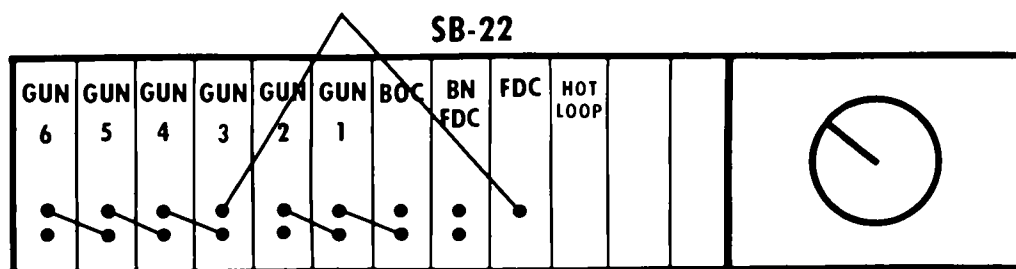
multiple fire missions. It consists of a TM-184 circuit board (①, fig 13-3) mounted on a steel stake (②, fig 13-3). The steel stake mount should be sharpened to a point at the bottom so that it can be driven into the ground. Seven U-17 jacks (③, fig 13-3) are screwed into the back of the TM-184 and wired to their respective posts (④, fig 13-3). This system allows maximum selectivity for the FD computer.

h. To give the BOC a switching capability, the SB-993 is used. Administrative lines, such as those to battalion headquarters and outposts, should be routed into the BOC. The following are examples of the flexibility this system allows.

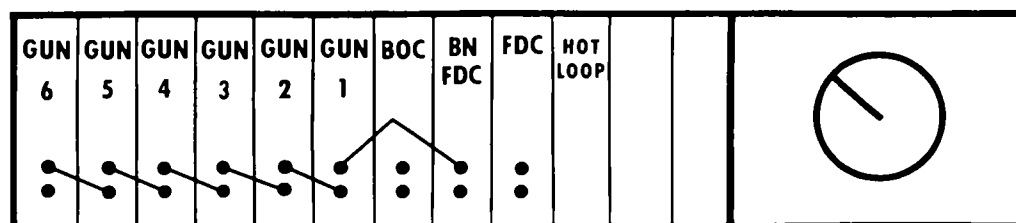
EXAMPLE 1—FDC firing center platoon only.



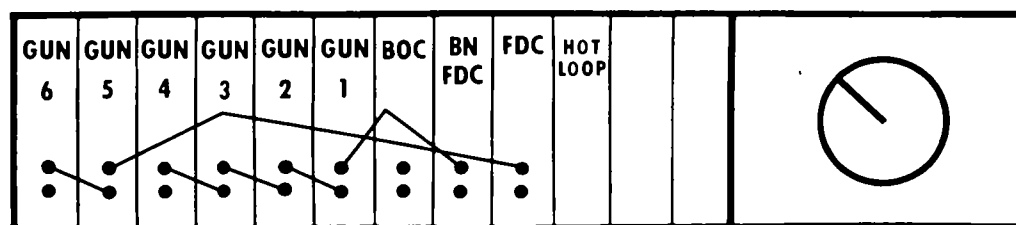
EXAMPLE 2—BOC firing right platoon, FDC firing center and left platoons.



EXAMPLE 3—In this example, the battalion FDC is controlling the fires of the battery. A suppressive fire mission is received at the battery from one of its FIST observers;



so, to fire the left platoon, battery FDC seizes control like this—



i. As soon as time permits, a "hot loop" should be laid for a backup as shown in figure 13-2, but it is not hooked up to the cannons until it is needed. The FDC and BOC hook up the hot loop to their switchboards. If, during a mission, one cannon loses its communications, its telephone should be immediately disconnected from the line to the terminal board and hooked up to the hot loop. The FDC is called and uses the hot loop circuit to communicate with that cannon until the line to the terminal board is repaired. If the seven-pair cable is broken, everyone utilizes the hot loop until repairs are made. (If you use WD-1 to make that cable, you will find it harder to damage and easier to repair than commercial types of cable.)

13-6. Priorities

Wire lines should be laid according to the

following priorities:

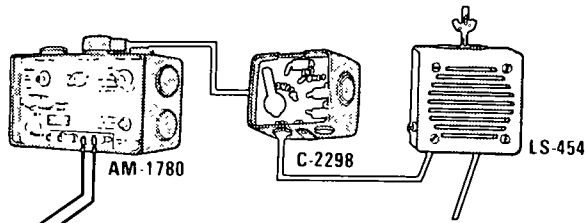
- All cannons plug into the SB-16.
- Wire lines are transferred to the terminal board. The BOC and FDC hook up into the terminal board.
- Outpost lines are laid by outpost personnel.
- Hot loop backup is laid.
- Administrative lines are installed.

13-7. Enhancing Wire Communications

a. One of the serious drawbacks of using the field telephone is that only the telephone operator hears the conversation. He must then relay the fire commands, and there is no check on what he says. One way of alleviating this problem and freeing one man

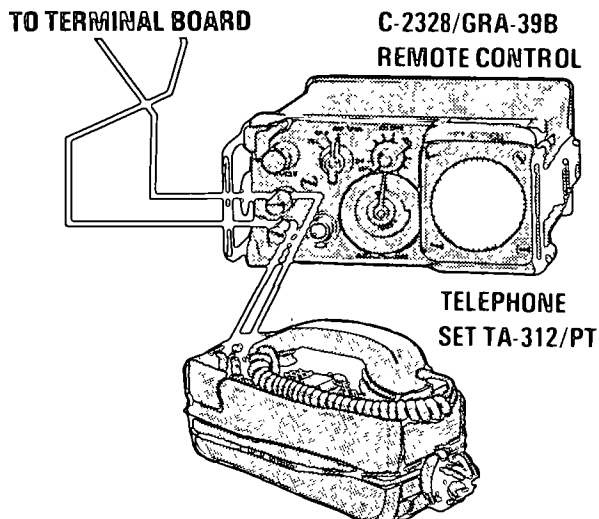
from monitoring a telephone is to use amplifiers and speakers at the howitzer and in FDC.

b. To install amplifiers and speakers in self-propelled units, the wire system may be run into the AN/VIC-1 intercommunications system as shown here.



A speaker LS-454 is hooked into the control unit C-2298 on the howitzer. The wire from the terminal board is connected to the external wire terminals on the howitzer. An obvious advantage of using this system is that all key members of the crew (chief of section, gunner, assistant gunner) hear the fire commands. *Command emphasis* must be placed on keeping the intercommunications systems operational. Both the artillery mechanic and the battery communications chief are qualified to troubleshoot the system. Routine maintenance is covered in the weapon technical manual. The AN/VIC-1 does not permit simultaneous transmit and receive operations; so strict communications discipline must be maintained.

c. In towed units and self-propelled units that may have inoperative intercommunications systems, the remote unit C-2328/GRA-39B should be placed at the



13-8. Training in Wire Operations

The personnel who utilize the intrabattery wire communications system are responsible for establishing it. This means that the cannon section, FDC, and BOC personnel must *all* know how to lay and splice wire, dig it in or overhead it, and operate their respective pieces of equipment. Table 13-2 is a list of tasks and appropriate personnel to perform those tasks. This training should be integrated into the field training of the unit.

13-9. The Small Unit Transceiver

a. In the future, each cannon section, FDC, and BOC will have a small unit transceiver, the AN/PRC-68. These radios are *not* intended to be used as the primary means of communications between the howitzer and the FDC. They are to be used to complement wire communications.

b. Because the positions occupied by the battery are spread out, installation of a hot loop backup to the wire system is quite time consuming, and the hot loop would have the same vulnerabilities to disruption as the primary wire circuit. The radio provides a means of continuing the mission while the hot loop is being installed or during periods when wire is disrupted by enemy action.

c. The radio can be the primary means of communication while the battery is being laid and until the wire circuits are installed. It can also be used to transmit fire commands, if necessary, while the wire system is being march ordered for battery displacements. The radios can be used for communications with supplementary positions and to control immediate actions while the battery is on the move. The low-power radios significantly enhance the battery internal communications capabilities—but only if properly utilized! All radios are subject to detection by the enemy. *Do not* allow lax communications procedures just because the radio has low power. Train the howitzer sections to properly use radios and to smoothly change over from wire to radio in case wire communications are disrupted.

13-10. Special Situations

In field exercises, the commander should

insure that personnel get the opportunity to practice setting up the intrabattery communications system *at night*. Other items that should be emphasized are—

a. Operation of the backup system. The unit should frequently simulate a disruption in the primary system due to counterfire, etc.

b. Simultaneous multiple fire missions. Both the FDC and the BOC should be drilled.

c. Use of telephones and radios while wearing a protective mask. An operator must have considerable practice in projecting his voice while wearing a protective mask.

13-11. Role of the Battery Communications Chief

With the consolidation of wire teams at the

battalion level, the role of the battery communications chief becomes one primarily of advising the commander on communications matters and troubleshooting equipment and the radio and wire systems. The two switchboard operators who are left in the communications section should be placed in the FDC to operate the SB-22. The communications chief's specific responsibilities are—

a. Assisting in the training of radio operators and telephone/switchboard operators.

b. Advising the battery commander on communications considerations during selection of a battery position.

Table 13-2. Wire Communications Tasks

TASKS	PERSONNEL				
	FDC	BOC	HOWITZER SECTION	OUTPOST PERS	COMMO SEC
Set up, operate, and maintain the telephone TA-312	X	X	X	X	X
Install and operate the switchboard SB-22	X				X
Install and operate the switchboard SB-993	X	X			X
Perform operator-level maintenance on assigned equipment.	X	X	X	X	X
Check field wire WD-1 for both open and short circuits.	X	X	X	X	X
Repair broken wire lines.	X	X	X	X	X
Hook up the hot loop.	X	X	X		X
Hook up wire to an SB-16 and the terminal board.	X	X	X		X
In SP units, operate the intercommunications system AN/VIC-1. Interconnect CVC helmets, telephones, and the loudspeakers LS-454 to the system.	X		X		X
In towed units, provide a loudspeaker capability for a wire circuit using a remote unit C-2328/GRA-39.	X	X	X	X	X
Overhead and/or bury wire lines correctly.	X	X	X	X	X

c. Monitoring the maintenance of communications equipment in the battery by making frequent spot checks.

d. Supervising the installation and monitoring the operation of the battery wire system.

e. Monitoring radio traffic to insure adherence to proper procedures and communications discipline.

f. Coordinating with the battalion communications chief on matters of personnel, communications equipment and supplies, and other support.

g. Keeping personnel informed on the proper use of the CEOI and authorized codes.

h. Supervising maintenance, training, and operations related to the battery's mine detectors.

THERE ARE TWO TYPES OF PRIMERS AVAILABLE FOR SEPARATE-LOADING AMMUNITION—THE MK2A4 (FOR THE M114A1 HOWITZER) AND THE M82 (FOR ALL OTHERS). MAKE SURE YOU HAVE THE RIGHT ONE!

c. Inspect all primers prior to use for signs of corrosion. If a seal has been broken, it is very likely that the primer has been affected by moisture and should be turned in.

14-9. Flash Reducers

a. Some propellants burn at such a low rate that flash reducers containing black powder and potassium sulfate must be used to reduce flash at night. The flash reducers also speed up the combustion of unburned propellant gases. This helps prevent excessive muzzle blast.

b. Flash reducers absorb moisture readily, so it is critical that they be kept *dry*. Keep them off damp ground and sealed in their containers until needed for use.

c. Discarded flash reducers should be disposed of in the same manner as igniter pads (para 14-5).

FLASH REDUCERS ARE HIGHLY FLAMMABLE. IT'S CRITICAL THAT THEY BE DISPOSED OF PROPERLY TO PREVENT INJURY.

14-10. Chemical Projectiles

a. Some chemical projectiles, because of their contents, require special handling and

storage. These are the toxic chemical and the white phosphorus (WP) shells.

b. When toxic chemicals are being fired, all personnel in the area should wear protective masks, and anyone handling the shell should wear gloves. There should be an ample supply of decontaminating agents available close by in case they're needed. If possible, these shells should be stored away from other types of ammunition and downwind of the battery area.

c. The WP round should be stored upright on its base, but any time the temperature of the ammunition reaches 110° F the round *must* be stored this way. If it's not, the filler will melt and shift to one side of the cavity in the projectile, which will cause the projectile to be unbalanced. The WP shells should be in an area free of all combustibles and away from other ammunition.

14-11. Segregation of Ammunition Lots

a. Different lots of propellant burn at different rates and give slightly different effects in the target area. For this reason, the registration corrections derived from one lot do not necessarily apply to another lot. Ammunition *must be segregated by lot*.

b. The FDC will designate the lot of ammunition to be fired for each mission (or it will be standardized), so the lot designator should be prominently displayed for each stack of ammunition.

c. In the field storage area, be it on vehicles or in a dump, lots of ammunition should be roped off with communications wire or twine and conspicuously marked with a cardboard sign or some such marker.

Section III. FIELD STORAGE OF AMMUNITION

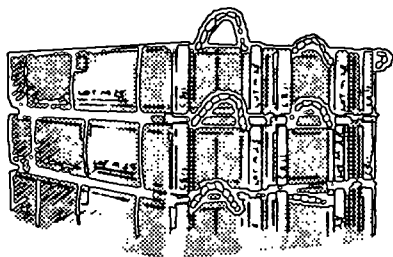
14-12. Hazards

a. The four greatest hazards to ammunition in the battery area are:

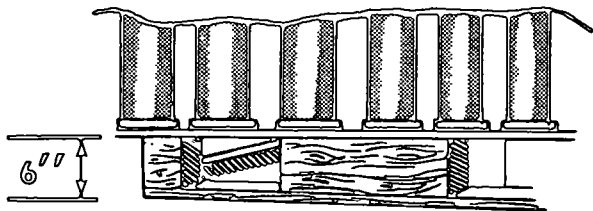
WEATHER,
ENEMY FIRE,
IMPROPER HANDLING,
and
CARELESS SMOKERS,
so,

regardless of the method of storage, these hazards must be given consideration. Specific storage techniques are discussed later in this section, but here are some general considerations:

(1) Stack ammunition by type, lot number, and weight zone.



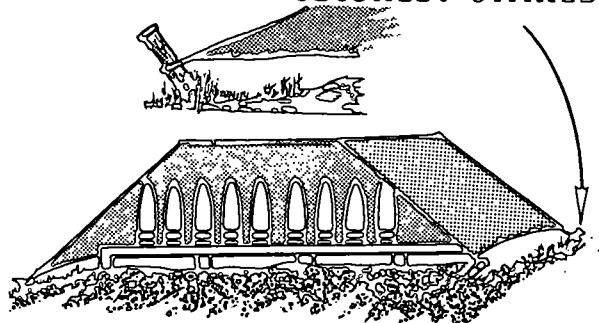
(2) If ammunition is being stored on the ground, use good strong dunnage at least 6 inches high under each stack.



(3) Keep the ammunition dry and out of direct sunlight by storing it in a vehicle or covering it with a tarp. Be sure adequate ventilation is provided.

(4) Provide ammunition, if offloaded, as much protection from enemy indirect fires as time and available materials allow. If sandbags are used for protection, keep the walls at least 6 inches from the stacks and the roof at least 18 inches from the stacks to insure proper ventilation.

PAULIN COVER
SECURELY STAKED



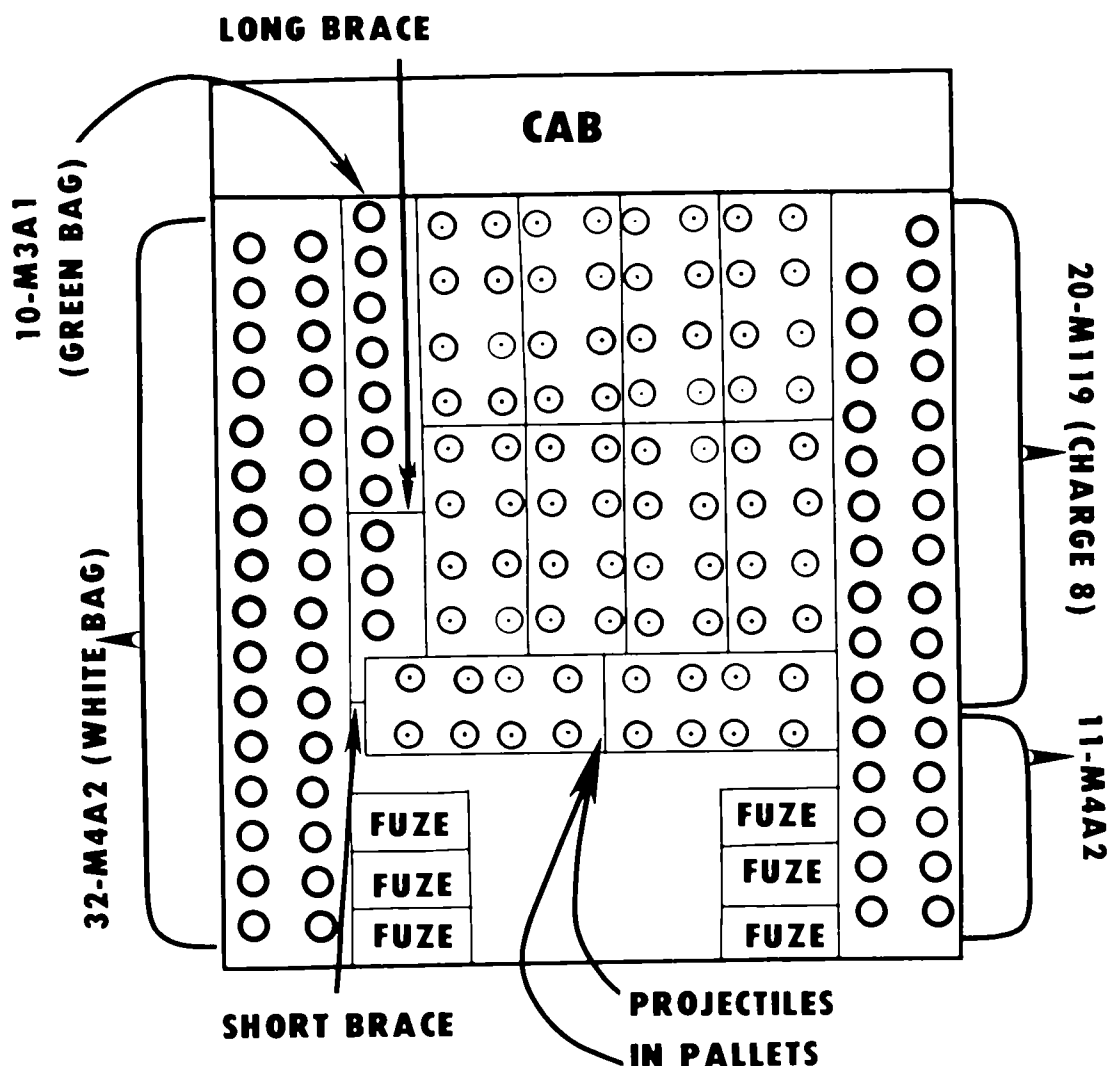
b. Particular attention must be paid to ammunition temperature. Most ammunition components can be stored at temperatures as low as -80°F for periods of not more than 3 days and as high as $+160^{\circ}\text{F}$ for periods of not more than 4 hours per day. An increase in malfunctions may be experienced with some VT fuzes when the temperature is below 0° or above 120°F . Powder temperature affects the muzzle velocity of a fired round and is a matter of frequent concern to the FDC. At least two howitzer sections should be designated to keep track of the powder temperature. A powder thermometer is inserted into the top powder increment in the canister, and care must be exercised to insure the thermometer does not touch metal.

CANNON SECTIONS MUST BE
CAREFUL NOT TO FIRE THE
POWDER THERMOMETER.

c. Only enough ammunition to meet current needs should ever be prepared at the pieces.

14-13. Storage Techniques

a. In SP units, the M548 cargo ammunition carrier is the companion vehicle to the howitzer and serves as an excellent area from which to service the weapon as well as a storage area for ammunition. Normally, the M548 should be positioned with its howitzer and replenished in the battery area by the ammunition section. Figure 14-2 shows a suggested method of loading the M548.



Notes.

1. Powder charges must be secured in the upright position.
2. Tiedowns over the top of ammunition pallets and secured to the floor of the carrier (to existing brackets) will keep the load from shifting.
3. Powder mix is arbitrary and will vary from unit to unit, depending on the tactical situation.
4. Load indicated is for an M109A1 howitzer section.

Figure 14-2. A typical M548 ammunition bed.

Ammunition should be left in pallets until needed for use. Figures 14-3 and 14-4 show recommended methods of securing the ammunition.

**BE SURE PALLETS ARE ADE-
QUATELY CRIBBED AND
SECURED TO PREVENT THEM
FROM SHIFTING DURING
MOVEMENT.**

b. In order to increase the ammunition-carrying capability of cannon batteries, additional M332 ammunition trailers are required in the TOE. Although some degradation in mobility may occur, an M332 trailer should be pulled by each of the following ammunition vehicles currently shown in various TOE: The 6-ton cargo carrier, the 2½- and 5-ton trucks, and the 8-ton GOER. These 1½-ton trailers can—

- (1) Increase organic hauling capability,

MATERIALS

- ① 2 pieces angle iron $\frac{1}{4}$ " x 2" x $1\frac{1}{2}$ " x 10'8" (top)
- ② 2 pieces angle iron $\frac{1}{4}$ " x 2" x 2" x 10'4" (bottom)
- ③ 4 pieces angle iron $\frac{1}{4}$ " x 2" x 16"
- ④ 4 pieces angle iron $\frac{1}{4}$ " x 2" x 12"
- ⑤ 14 pieces strap iron $\frac{1}{4}$ " x $1\frac{1}{2}$ " x 3'2"
- ⑥ 6- $\frac{1}{2}$ " x $1\frac{1}{2}$ " cap screws with lockwashers
- ⑦ 4-4 $\frac{1}{2}$ " to 5" butt hinges

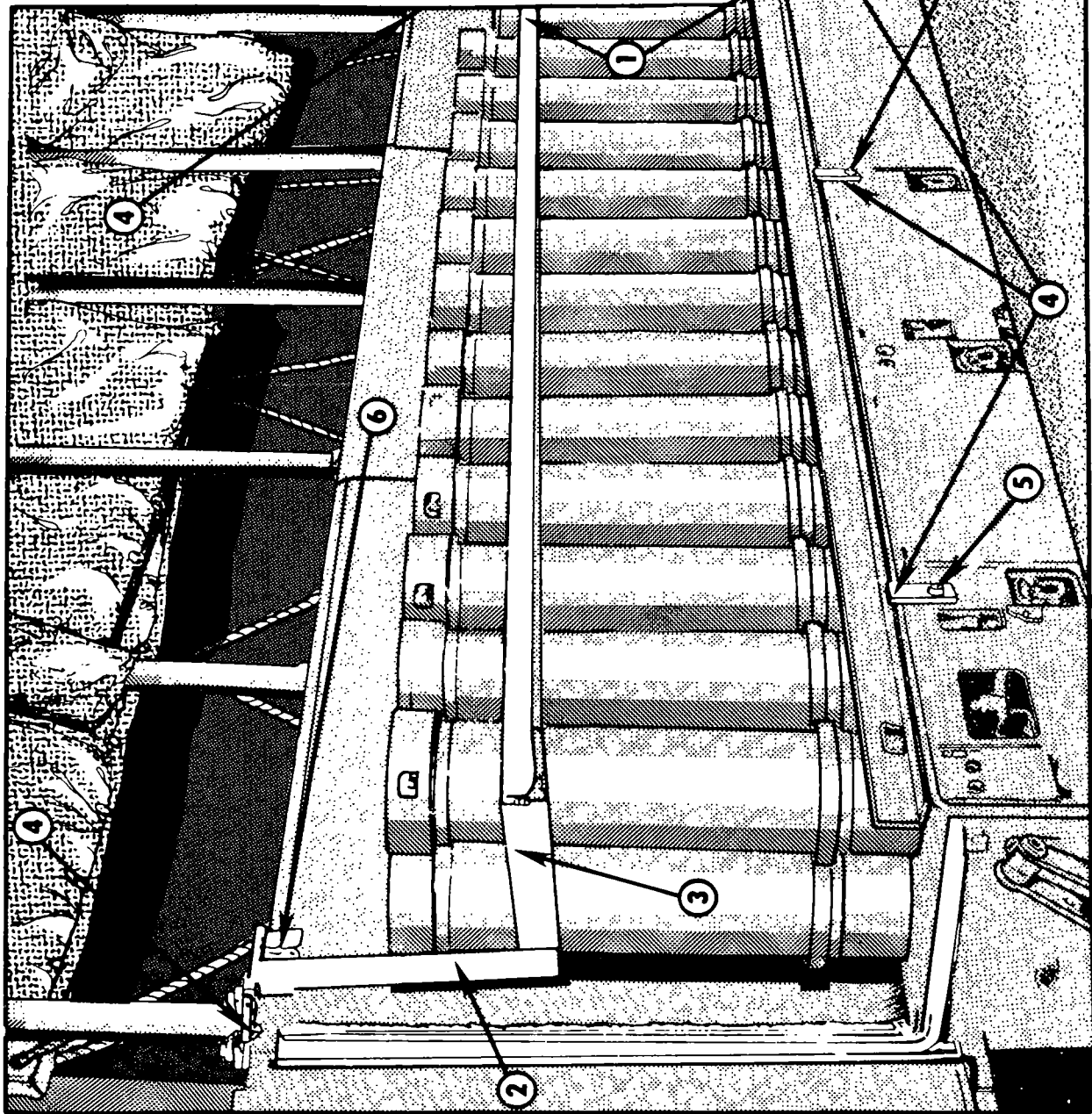
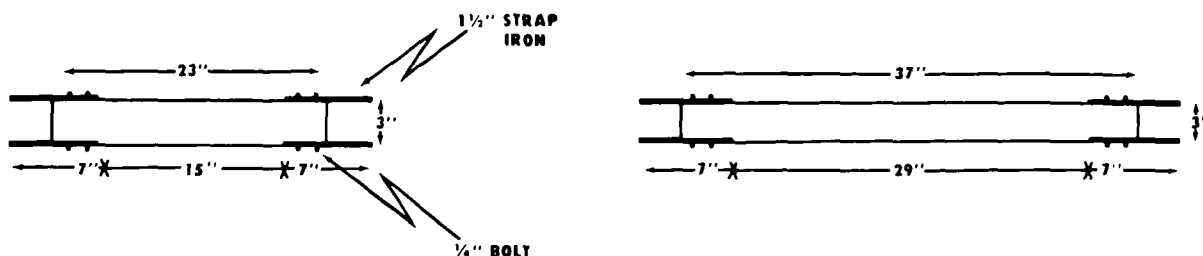


Figure 14-3. Canister holddown brackets.



These braces should be used with the full load shown in figure 14-2. The short brace is used for three pallets and the long one for two. When either type of brace is used, the pallet top will be fitted between the strap iron brackets in the 3-inch gap. Two braces will be used between pallets.

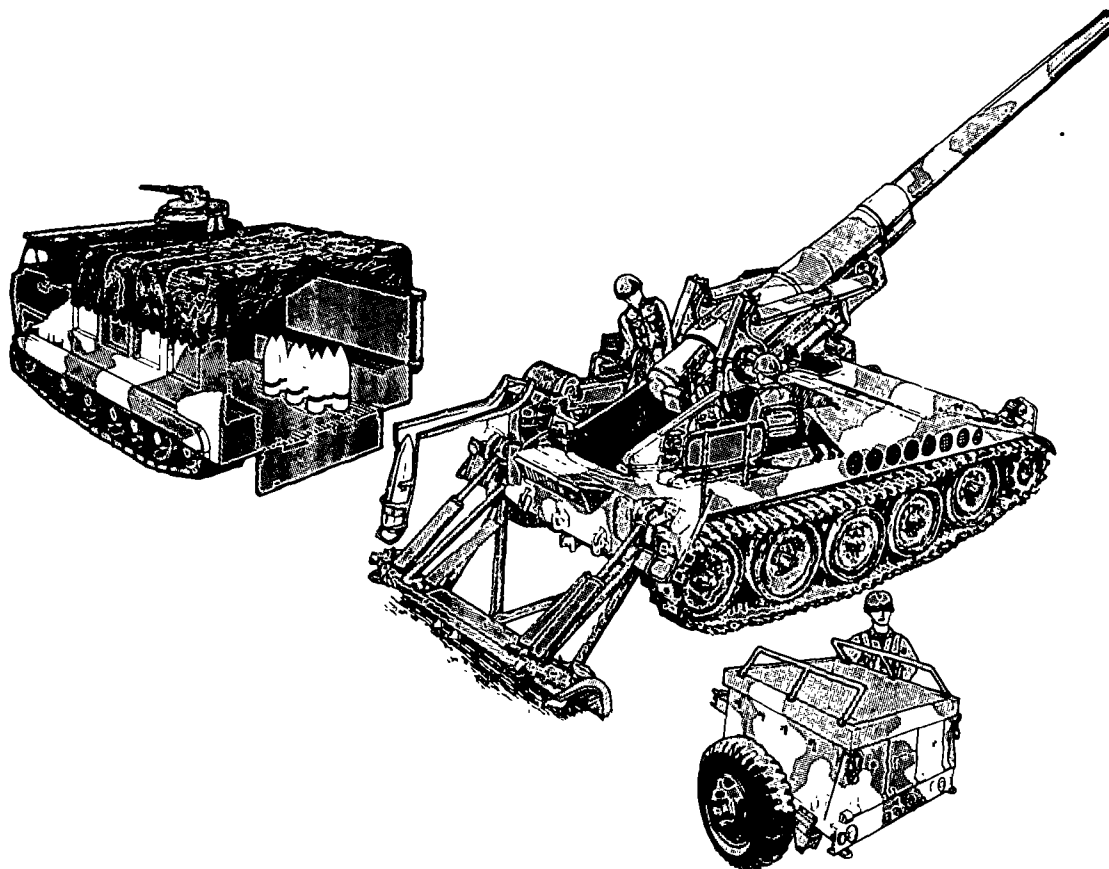
Figure 14-4. Pallet braces for securing ammunition pallets.

(2) Facilitate resupply and backhaul operations, and

(3) Permit ammunition component segregation (to reduce the battery's vulnerability to counterfire).

c. In towed units, the prime mover, loaded with ammunition, should be positioned near

the howitzer. Ammunition should be left loaded until it is prepared for firing. Other ammunition is stored on the battery ammunition section vehicles, or at a battery ammunition dump. The establishment of a battery ammunition dump is a matter of command decision, because it seriously impairs the mobility of the battery.



Section IV. MISCELLANEOUS

14-14. Accidents

Generally, firing accidents are serious in nature, so all supervisory personnel should know the immediate action to be taken. Here are some general guidelines for use in the development of a sound SOP:

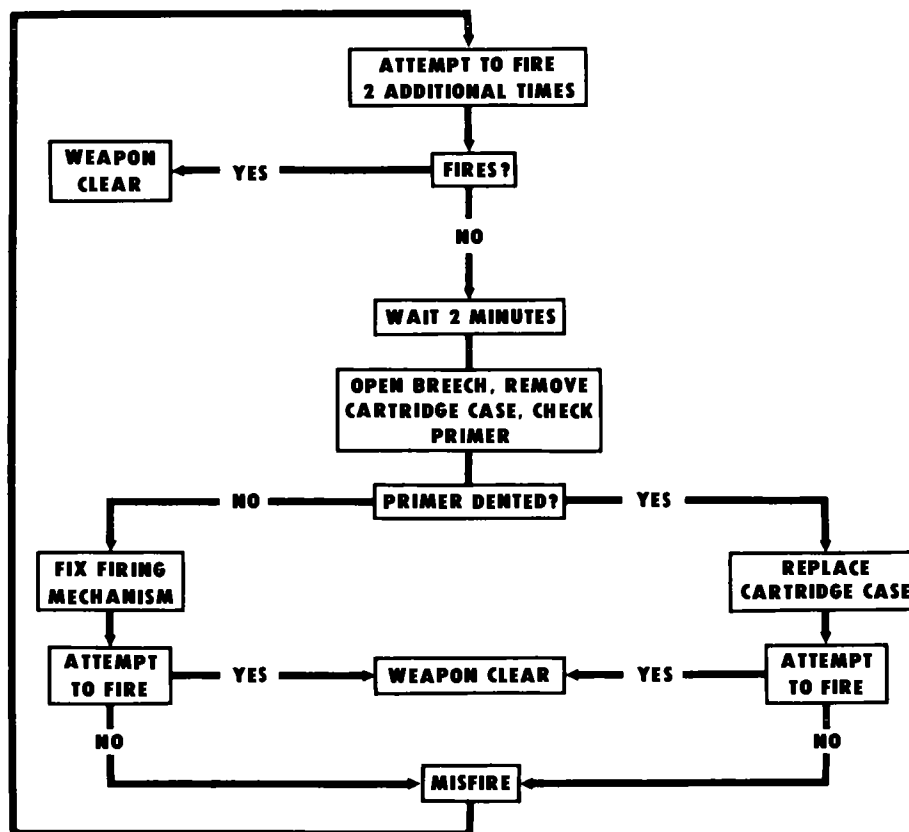
- a. Render first aid to injured personnel; then call for medical assistance.
- b. If the ammunition or equipment presents further danger, move all personnel out of the area.
- c. Do not change any settings on, or modify the position of, the weapon in any way until an investigation has been completed.
- d. Record the lot number of the ammunition involved in the accident or malfunction and report it to the battalion

ammunition officer. If there is good reason to suspect a particular lot of ammunition, its use should be suspended by the XO.

14-15. Misfire Procedures

Misfires *do* occur, and when they do, there are specific things that must be done within specific time limits. For that reason, personnel must be thoroughly familiar with the applicable misfire procedures and the hot tube loading precautions. Figures 14-5 through 14-7 show the misfire procedures for semifixed and separate-loading ammunition in both cold tube and hot tube situations. Specific hot tube precautions are as follows:

- a. Do not load a round until immediately prior to firing.
- b. Fire or remove any round within 5



The misfire procedures for semifixed ammunition, hot tube, are the same as those for a cold tube with the exception that the hot tube precautions (para 14-15) must be observed.

Figure 14-5. Misfire procedures, semifixed ammunition, cold tube.

MINUTES after it has been loaded.

c. If the round cannot be removed or fired within 5 minutes—

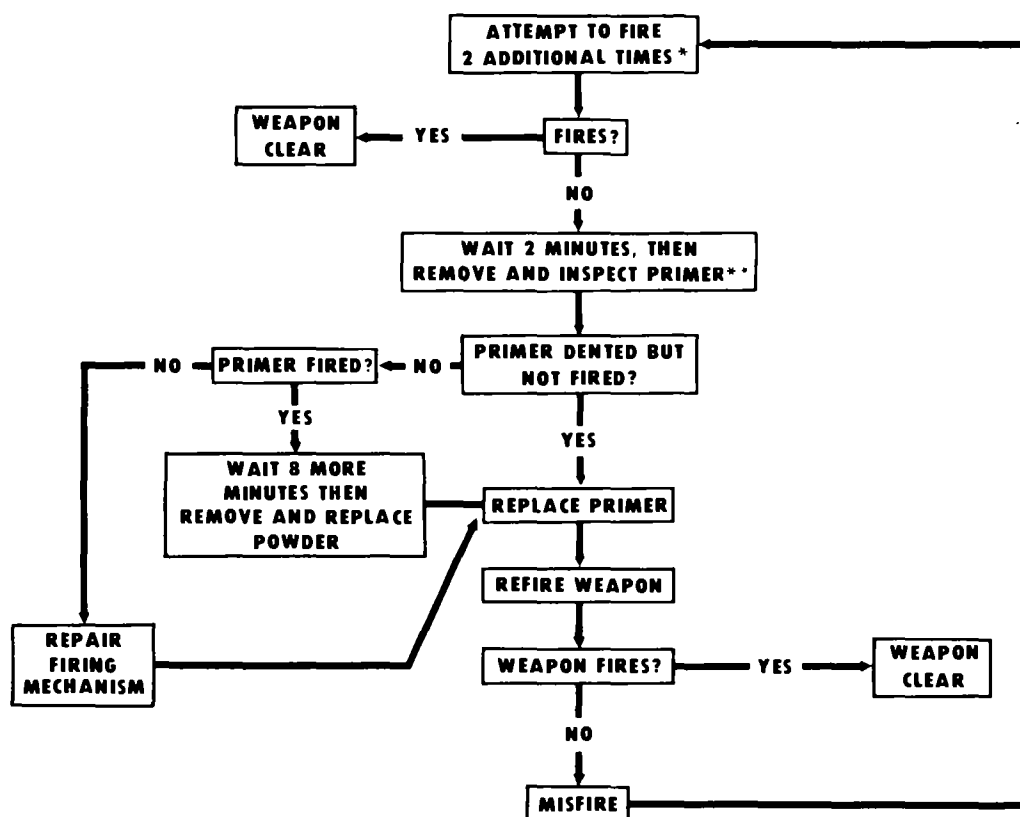
(1) REMOVE THE PRIMER AND PROPELLING CHARGE OR CARTRIDGE.

(2) HAVE THE CREW EVACUATE THE WEAPON.

(3) LET THE WEAPON COOL FOR 2 HOURS BEFORE ATTEMPTING TO EXTRACT THE ROUND. Call ordnance, if necessary, to assist in extracting the round.

14-16. Training

a. Ammunition training has traditionally been a weak area. Cannoneers seldom get to practice setting time fuzes or cutting propellant charges until the battery goes to the field to conduct live firing. There are several training extension course (TEC) lessons on ammunition to enhance individual training. Additionally, your Training and Audiovisual Support Center (TASC) has an excellent selection of ammunition training materials.



*Do not attempt to fire the 175-mm gun two additional times if firing zone 3.

**If firing the M109A1, charge 1, the following apply (see note):

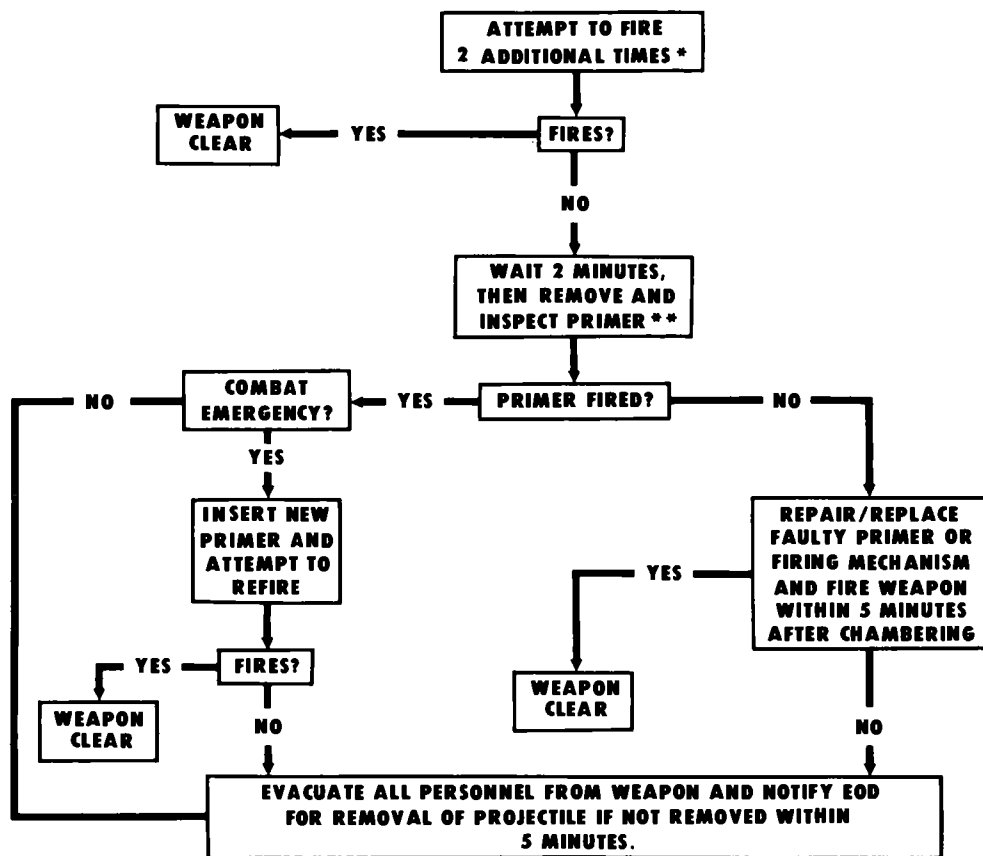
1. Open rear of cab.
2. Position tube so primer can be expelled outside if a sticker is involved.
3. Open the firing lock.
4. If a sticker is involved, refire with charge 4 or higher. If not, inspect the primer and proceed through the remainder of the misfire procedures.

Note. Occasionally, in firing charge 1 with the M109A1, a round will lodge in the tube after normal functioning of the ignition train. This round is called a STICKER, and when it occurs, gases under high pressure are trapped in the chamber.

Figure 14-6. Misfire procedures, separate-loading ammunition, cold tube.

b. Collective training can be enhanced by the use of training rounds, which are available through the local training aids office. New training rounds are constantly being introduced into the training aids inventory. These rounds are designed to

exercise the entire howitzer crew—from loading, cribbing, and handling ammunition to setting fuzes, cutting charges, loading, and firing. Keep an up-to-date TASC catalog and take advantage of these devices. More tips on training ammunition section personnel are found in chapter 17.



*Do not attempt to fire the 175-mm gun two additional times if firing zone 3.

**If firing the M109A1 with charge 1, observe the sticker precaution in the preceding figure.

Figure 14-7. Misfire procedures, separate-loading ammunition, hot tube.

CHAPTER 15

DUTIES OF SAFETY PERSONNEL DURING SERVICE PRACTICE FIRING

Section I. INTRODUCTION

15-1. General

a. The military profession is, by its very nature, a dangerous business. An error or an unforeseen accident can have fatal results. Safety must always be on the minds of everyone. The artilleryman, perhaps more than others, must constantly guard against that one round fired in error. Its effects can be enormous. The round does not know the difference between civilians and military. One friendly round falling on friendly troops can destroy morale and the close teamwork necessary within the combined arms team.

b. The importance of safety is well recognized. The concern for safety can, however, be counterproductive. It can influence training to the extent that realistic combat training is nearly impossible. It is the duty of every leader to be sure that concern for safety is effective. At the battery, there is much that can be done. Each supervisor must know his job before supervising troops in the conduct of live ammunition firing. Most accidents are the result of ignorance, not carelessness. The chief of a howitzer section must know his job and his responsibility for accurately firing the data given his section. The same applies to fire direction personnel in the development of that data.

c. This chapter reinforces AR 385-63 and pertains primarily to peacetime safety practices and procedures. However, the information herein can also be applied in combat situations. In any instance where local range regulations contradict the material in this chapter, the local range regulations must be followed. The responsibilities for safety are fixed as follows.

(1) *The range officer* provides the officer in charge (OIC) of firing with a safety card stating the geographic limits of the impact area into which all artillery fire must be directed.

(2) *The officer in charge of firing* is normally the commander or OIC of the unit conducting firing. He is responsible for insuring that rounds, when fired, land within the designated impact area.

(3) *The safety officer/NCO* is directly responsible to the OIC of firing for safety at the weapons. This duty may be performed by a certified safety officer or noncommissioned officer in the grade of E6 or above. Normally, this duty will be performed by the XO or chief of firing battery. The safety officer/NCO must be competent and qualified to perform his duties, as he is responsible for insuring that all rounds fired are within the safety limits as shown on the safety diagram. Specific duties are covered in subsequent paragraphs. Also, sample safety problems and a sample test for the qualification of safety personnel is in appendix E.

(4) *The executive officer* is responsible for insuring that safe practices are followed in ammunition handling, in laying for direction and elevation, and in all other operations performed by the firing battery.

(5) *The fire direction officer* prepares the safety diagram and verifies the plotting of safety limits on the firing chart. He insures that fire commands sent to the firing sections are within the specified limits.

(6) *The howitzer/gun chief of section* accepts final responsibility for the safety of the weapon and crew after the safety officer/NCO gives the clearance to fire. He insures that his section fires only serviceable rounds of authorized ammunition with the proper charge, and that the firing data sent to the section are properly set on the weapon. The commander *must* insure that all his personnel are qualified to perform their safety duties.

15-2. Duties of the Safety Officer/ NCO

a. The safety officer/NCO must be thoroughly familiar with five references. They are *AR 385-63*, *FM 6-50*, *TM 43-0001-28*, *the appropriate TM for the weapon*, and *local range regulations*. His specific duties are as follows:

(1) *Before firing—*

(a) Verify that the safety card applies to the unit firing, that the unit is in the correct location, and that the data are correct.

(b) Verify the safety diagram (para 15-5).

(c) Check the weapons for correct boresighting.

(d) Verify the lay of the battery.

(e) Verify the minimum quadrant elevation determined by the executive officer.

(f) Compare the XO's minimum QE with the quadrant elevation for minimum range shown on the safety diagram, and use the larger of the two as the minimum QE.

(g) Supervise and check the emplacement of safety aids (stakes, safety tape, and other devices).

(h) Verify that the ammunition to be fired is of the type specified on the safety card.

(i) Insure that the chiefs of section are informed of maximum and minimum quadrant elevations, right and left deflection limits, and minimum fuze settings.

(j) Verify that range clearance has been obtained by checking with the officer in charge of firing.

(k) Ascertain or confirm that the visible portion of the impact area is clear of personnel.

(l) Insure compliance with Department of the Army regulations, local range regulations, and local special instructions pertaining to safety. When the checks required before firing have been made, the safety officer informs the OIC that it is safe for the battery to fire.

(2) *During firing—*

(a) Verify the serviceability of ammunition.

(b) Insure that the charges, projectiles, and fuzes being fired are only those prescribed on the safety card.

(c) Insure that rounds are not fired below the minimum quadrant elevation or above the maximum quadrant elevation.

(d) Insure that rounds are not fired outside the lateral safety limits specified on the safety card.

(e) Insure that time-fuzed rounds are not fired with fuze settings that are less than the minimum time prescribed on the safety diagram.

(f) Require that unused powder increments be displayed for each round to be fired.

(g) On all commands that are unsafe to fire, command UNSAFE TO FIRE and give the reasons. Examples are:

**UNSAFE TO FIRE
3 MILS OUTSIDE RIGHT
SAFETY LIMIT AND 20 MILS
ABOVE MAXIMUM
QUADRANT ELEVATION.**

**UNSAFE TO FIRE
5 MILS BELOW MINIMUM
QUADRANT ELEVATION.**

(h) Apply registration corrections to the safety limits immediately after registration.

(i) By a positive act, such as a hand signal or a voice command, indicate to the chief of section when it is safe to fire.

(j) Report accidents and malfunctions of ammunition to the officer in charge of firing and make those reports required by local range regulations and AR 385-63.

(k) Bring to the attention of the OIC any unsafe conditions observed and suspend firing until these conditions have been corrected. Examples of unsafe conditions are:

Safety features of the weapon not operable.

Powder bags exposed to fire.

Personnel smoking near pieces.

Improper handling of ammunition.

Time fuzes previously set and not reset to safe.

Personnel or aircraft directly in front of the weapons.

Primer inserted into the firing assembly before breech is closed (separate-loading ammunition).

Failure to inspect powder chamber and bore after each round is fired.

Failure to swab powder chamber after each round of separate-loading ammunition is fired.

Misfires (para 14-15). The safety officer/NCO must insure that the cannon personnel follow the prescribed misfire procedures.

b. The safety officer performs his duties in a manner that insures compliance with all safety regulations and limits; however, he should not use procedures that will unnecessarily delay the delivery of fire.

15-3. The Safety Card

The range officer prepares a safety card prescribing the hours of firing, the areas in which firing will take place, the location of the gun position, the limits of the impact area, and other pertinent data to provide a safety zone that will insure that rounds with maximum dispersion fall in a safe area. The officer in charge of firing gives the card to the FDO, who constructs a diagram showing the limits prescribed on the safety card. The data are then verified by the safety officer/NCO. Figure 15-1 shows a typical range safety card and the format that should be used.

15-4. Safety Aids

a. The safety officer should use whatever visual aids he can devise to help him in verifying that the howitzers are laid within the safety limits. Two such aids are safety stakes (towed weapons), and safety tape (M109/M109A1). These aids, each of which is discussed below, may be used as guides for any deflection (and quadrant on the M109/M109A1) not within 20 mils of a safety limit. If a deflection announced is within 20 mils of a limit, the safety officer should go to the piece and verify sight settings.

b. To emplace safety stakes—

RANGE SAFETY CARD			
UNIT/STR:	1st Bn 64th FA	DATE-TIME GP:	0710-2100 Tue 7 Feb 78
FIRING POINT:	322W (2753 1549)	AREA:	NKA
WEAPON:	155H (M109A1)	AMMUNITION:	SH HF, FZ M557 M564 M514; SH WP, FZ M557 M564; SH ICM ILLUM, FZ M565; SH HC, FZ M501
TYPE OF FIRE:	High & Low Angle		
DIRECTION LIMITS: (Ref GN):	LEFT 4730	MILS, RIGHT 5450	MILS
LOW ANGLE PD MINIMUM RANGE	2000	METERS, MINIMUM CHARGE	2
FUZE TI, VT & HI ANGLE MINIMUM RANGE	2400	METERS, MINIMUM CHARGE	2
MAXIMUM RANGE TO IMPACT	5800	METERS, MAXIMUM CHARGE	4
SPECIAL INSTRUCTIONS: Apply +5.5 seconds to Time of Flight corresponding to Range 2000 to establish Minimum Time for Fuze VT.			
See reverse side for special instructions as appropriate to authorized weapons, fuzes, and projectiles.			
White bag not authorized.			
From AZ 4730 to AZ 5030, Max Rq 5000, Max Chg 4.			

Figure 15-1. Range safety card.

(1) Set on the sight, in turn, the left, intermediate, and right deflection limits and take up a proper sight picture on the collimator or aiming posts.

(2) Sight through the breech end of the tube and, sighting along the left edge of the tube for the left limit and the right edge of the tube for the right limit, align the safety stakes. They should be firmly driven into the ground approximately 10 feet in front of the tube.

c. Safety tape provides a convenient and fast method of verifying firing data on the M109/M109A1 weapons. As shown in figure 15-2, an index is placed on the moveable portion of the hull. Then the weapon is traversed to the left and right limits, and at each limit a piece of tape is placed on the lower hull under the index. By the same method, tape can be placed on the tube and on the front of the upper hull to indicate elevation limits.

d. From the range safety card, the FDO prepares a safety diagram and a safety "T" for the safety officer/NCO. The safety "T" is a convenient method of arranging the safety data. A 3 inch x 5 inch card may be used. Here is the safety "T" for the data computed in section II of this chapter.

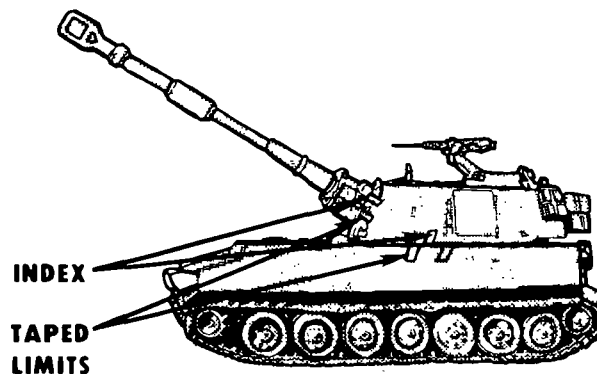


Figure 15-2. Safety tape.

(Maximum QE)

(Deflection limits)

(Minimum QE Ti & VT)

(Minimum FS M564)

(Minimum FS M514)

(Minimum FS M501)

(Minimum QE PD)

(Minimum QE WP)

CHG 4 GB		
	299	361
3570	3270	2850
	123	Min QE Ti & VT
	7.9	M564
	13.0	M514
	8.3	M501
	115	Min QE Q
	126	Min QE WP

Section II. COMPUTATION OF SAFETY DATA

15-5. Construction of the Basic Safety Diagram

A basic safety diagram is a rough graphical representation of the data on the safety card.

Prior to registration, the FDO must construct the basic safety diagram using the following procedures:

a. To determine the deflection limits—

(1) On a sheet of paper, draw a line representing the lay of the battery (initial direction of fire) (fig 15-3). Label this line with its azimuth and the common deflection.



Figure 15-3. Direction.

(2) Compute the angular measurements to the right and left safety limits by comparing the azimuth on which the battery is laid (given by the battery commander) with the azimuths of the right and left limits as shown on the safety card (fig 15-1). Draw and label arrows indicating the angular measurements as shown in figure 15-4.

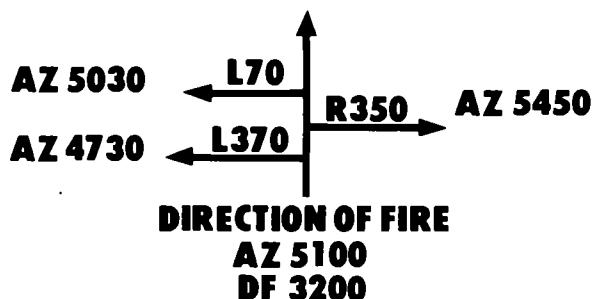


Figure 15-4. Angular measurements.

(3) Draw lines representing the lateral limits in proper relation to the line on which the battery is laid. Apply the angular measurements to the deflection corresponding to the direction of fire to determine the deflection limits; use the "LARS" rule (Left, Add/Right, Subtract). Label the deflection limits (fig 15-5).

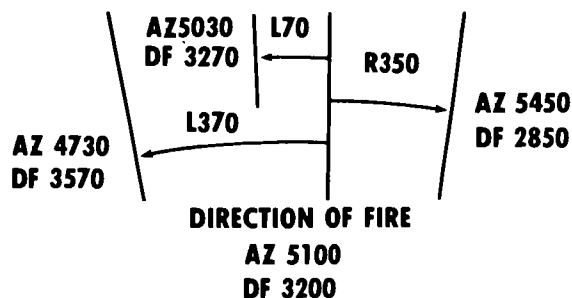


Figure 15-5. Deflection limits.

b. Draw arcs between the lateral safety limits to represent the minimum and maximum ranges shown on the safety card. Label each arc with the appropriate range. A completed basic safety diagram is shown in figure 15-6.

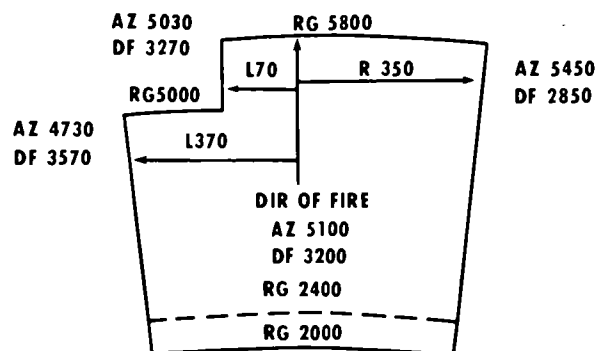


Figure 15-6. Basic range safety diagram.

15-6. Safety Data for Shell HE

a. After the basic safety diagram has been drawn on a sheet of paper, it must be constructed on a map of the impact area using a range deflection protractor (RDP). These limits must be drawn *accurately*, because they will be used to determine altitudes for vertical intervals. Determine the highest altitude on the minimum range line. This will be used to insure that, regardless of the deflection fired, the round will clear the highest point and land within the impact area. At the maximum range, select the minimum altitude to insure that the round will not clear the maximum range.

NOTE: THE RULE FOR DETERMINING THE CORRECT ALTITUDE FOR SAFETY PURPOSES IS CALLED THE "MINI-MAX" RULE: AT THE MINIMUM RANGE SELECT THE MAXIMUM ALTITUDE ON THE MINIMUM RANGE LINE; AT THE MAXIMUM RANGE SELECT THE MINIMUM ALTITUDE ON THE MAXIMUM RANGE LINE.

If the contour interval is in feet, either the GST or a feet-to-meters conversion table must be used to convert the altitude to meters.

b. Determine the *vertical interval* by subtracting the battery altitude from the

altitude of the applicable range line. The vertical intervals for this problem have been determined in the following manner:

(1) From the diagram constructed in accordance with *a* above, determine the following altitudes:

(a) Maximum altitude at minimum range 2000 = 411 M

(b) Maximum altitude at minimum range 2400 = 380 M

(c) Minimum altitude at maximum range 5000 = 409 M

(d) Minimum altitude at maximum range 5800 = 406M

(2) The battery altitude is 390 M (scaled from map or determined by survey).

(3) Compute the vertical intervals:

(a) Minimum range 2000: $411-390 = +21$ VI

(b) Minimum range 2400: $380-390 = -10$ VI

(c) Maximum range 5000: $409-390 = +19$ VI

(d) Maximum range 5800: $406-390 = +16$ VI

c. To determine minimum quadrant elevation (min QE):

(1) For each charge, algebraically add the elevation for the minimum range to the site at the highest altitude along the minimum range line.

(a) Determine elevation to the nearest mil by using the GFT whenever possible. For ranges not shown on the GFT, use the tabular firing table (TFT). Express the elevation to the nearest mil.

(b) Determine site to the nearest mil by using the GST site-range scales whenever possible. For ranges not shown on these scales, use the tabular firing table. In this case, determine the angle of site by using the C and D scales on the GST. Determine the comp site factor by entering table G of the TFT. (If the range is not listed, enter table G with the next highest listed range.) After

extracting the comp site factor from table G, multiply it by the angle of site. The result is the complementary angle of site. To determine site, add the angle of site to the complementary angle of site.

(2) Example: Minimum QE for impact fuze minimum range—

Vertical interval (411-390)	= +21 meters
Angle of site (GST = $+21/2000$)	= +10.7
Comp site (0.010×10.7)	= 0.1
Site	= +11
Elevation for 2000 meters (GFT) Chg 4 GB	= 104
Minimum quadrant elevation	= 115 mils

(3) Example: Minimum QE for time fuze minimum range—

Vertical interval (380-390)	= -10 meters
Angle of site (GST = $-10/2400$)	= -4.2
Comp site ($-.01 \times -4.2$)	= 0.0
Site	= -4.2 = -4
Elevation for 2400 meters (GFT) Chg 4 GB	= 127
Minimum quadrant elevation	= 123 mils

d. To determine maximum quadrant elevation (Max QE):

(1) For each charge, algebraically add the elevation for the maximum range to the site at the lowest altitude along the maximum range line.

(2) Example: Maximum QE (left segment)—

(a) Using the maximum range, determine the elevation as described in c(1)(a) above.

(b) Using the maximum range, determine site as described in c(1)(b) above. Use GST site-range scales whenever possible.

(c) Apply site to elevation to determine maximum QE:

Vertical interval (409-390)	= +19 meters
-----------------------------	--------------

Site (GST) = +4
 Elevation for 5000 meters (GFT) = 295
 Maximum quadrant elevation = 299 mils

(3) Example: Maximum QE (right segment)—

Vertical interval (406-390) = +16 meters
 Site (GST) = +3
 Elevation for 5800 meters (GFT) = 358
 Maximum quadrant elevation = 361 mils

e. Minimum fuze settings (Min FS) are as follows:

(1) Fuze M564. The minimum fuze setting for fuze M564 is that setting corresponding to the elevation for the minimum time range. This may be the same range listed for fuze quick. If only one minimum range is listed on the range safety card, that range will be used for all fuze types. Before registration, the fuze setting is determined by placing the manufacturer's hairline over the range and reading the corresponding fuze setting from the GFT. The TFT may be used to determine the fuze setting by entering the TFT with range and

extracting the corresponding value in the "FS for graze burst M564" column of table F. Insure that the time of flight is not extracted, since the fuze setting for M564 and time of flight (in seconds) are not necessarily the same.

Example: Minimum fuze setting (M564)—

Elevation for minimum range (2400M) = 127
 Minimum fuze setting for fuze M564 = 7.9

(2) Fuzes M513, M514, and M728 (VT). The minimum fuze setting for proximity (VT) fuzes M513, M514, and M728 is the time of flight corresponding to the elevation for minimum range plus 5.5 seconds. The result is rounded up to the next higher whole second. The time of flight is obtained by entering table F of the TFT with the minimum range and extracting the corresponding time of flight, unless other directions are given under special instructions on the safety card (see fig 15-1). Range is used as the entry argument because elevation and range correspond prior to registration, and range is the more convenient element to use. The fuze time minimum quadrant is used for the minimum quadrant of a round with VT fuze.

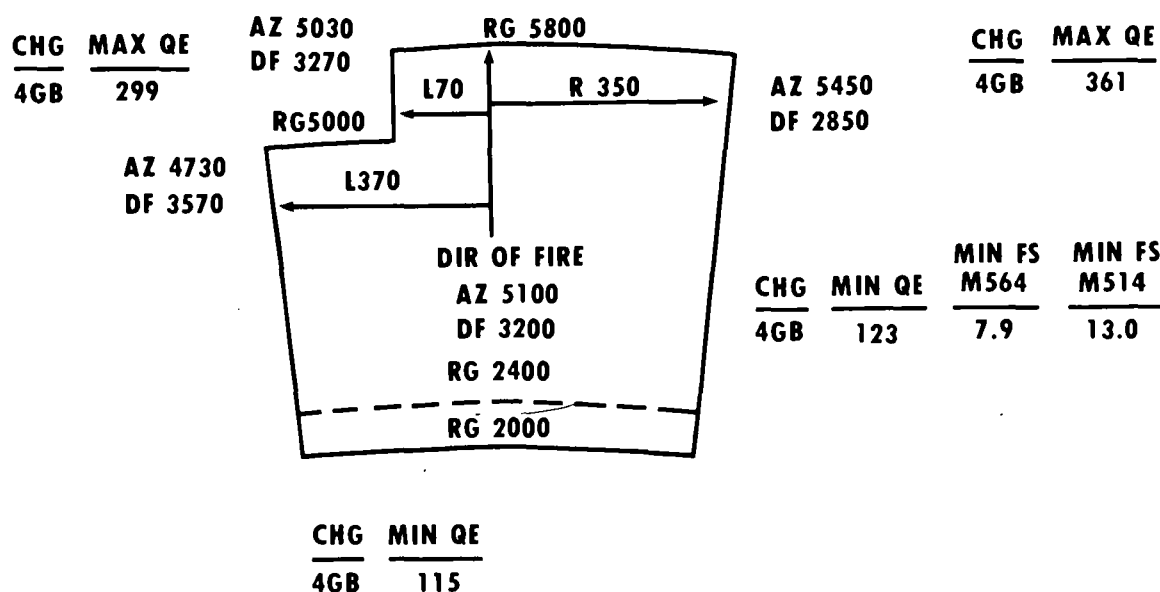


Figure 15-7. Completed safety diagram prior to registration.

Example: Minimum fuze setting (M514)—

Elevation for minimum range (2000M)	= 104
Time of flight (from TFT)	= 6.6
Plus 5.5 seconds	= 5.5
	12.1 = 13.0
Minimum fuze setting for fuze M514	= 13.0

f. Computation of minimum and maximum quadrant elevations and the minimum fuze settings completes the basic safety diagram prior to registration. See figure 15-7. Maximum fuze settings are not determined, since rounds fired at the maximum quadrant elevation will impact within the designated area even if the fuze setting is too great.

NOTE: SAFETY DATA COMPUTED AS SHOWN IN PARA 15-6 IS FOR THE STANDARD WEIGHT HE PROJECTILE. IF YOU ARE FIRING OTHER THAN THE STANDARD, A WEIGHT CORRECTION FACTOR MUST BE APPLIED WHEN COMPUTING SAFETY DATA. SEE PARA 15-10.

15-7. Safety Diagram After Registration

After a registration has been fired and corrections have been obtained, the FDO modifies the original basic safety diagram by applying the registration corrections. He changes the elevations on the basis of the GFT setting obtained from the registration, and alters the deflections for the lateral limits by the amount of the total deflection correction. The following elements and computations are involved:

a. Deflection. Determine the deflection limits by applying the total deflection correction to the deflection limits of the basic safety diagram.

b. Quadrant elevation. The minimum quadrant elevation is the sum of the site and elevation for the minimum range; the maximum quadrant elevation is the sum of the site and elevation for the maximum

range. Compute quadrant elevation as follows:

(1) After registration, construct the GFT setting on the GFT and read the elevations for minimum and maximum ranges under the elevation gage line.

(2) Use the site computed prior to registration.

(3) Add the new elevation to the already computed site to obtain the quadrant.

c. Minimum fuze settings.

(1) After a time registration has been conducted, the minimum fuze setting for time fuzes is the fuze setting corresponding to the minimum elevation (*b*(1) above) plus the fuze correction determined from registration. On the GFT, read the minimum fuze setting under the time gage line.

(2) Determine the fuze setting for a VT fuze by reading the time of flight in the TFT corresponding to the elevation determined in *b*(1) above or the next higher listed elevation, adding 5.5 seconds, and then rounding the results to the next higher whole second.

d. Example: Safety diagram after registration—

(1) *Situation.* Assume that you have conducted a registration and obtained the following GFT setting and deflection correction: GFT B: Chg 4, lot WS, rg 4400, el 277, ti 16.7 and total deflection correction L3. Figure 15-8 shows the basic safety diagram (fig 15-7) modified by the amount of the registration corrections.

(2) *Deflection after registration.* Apply L3 to all deflections computed prior to registration.

(3) *Minimum quadrant elevation.* If the GFT does not extend to the minimum range, compute a range *K* (see FM 6-40) and apply it to the minimum range to determine a corrected minimum range. The minimum quadrant elevation is the tabular firing table elevation corresponding to the corrected minimum range plus the site computed prior to registration.

Example: Minimum quadrant elevation—

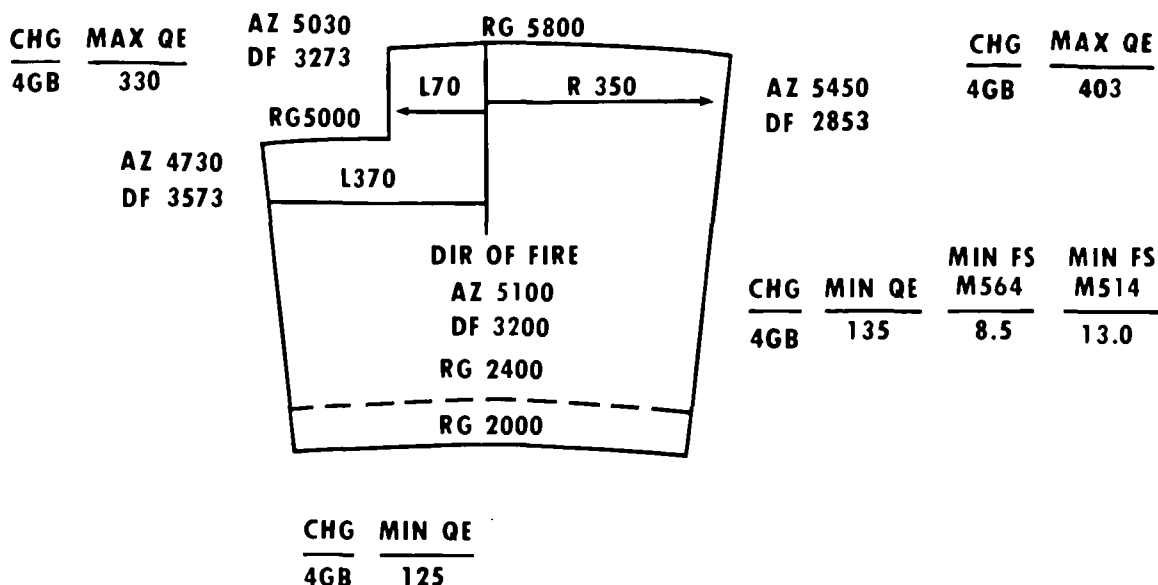


Figure 15-8. Safety diagram after registration.

Minimum range	= 2000 meters
Elevation for range	= 114
Site	= +11
Minimum quadrant elevation (2000 meters)	= 125

Elevation range 5000 meters (GFT)	= 326
Site	= +4
Maximum QE	= 330

(7) *Maximum quadrant elevation—range 5800.*

Minimum range	= 2400 meters
Elevation for range	= 139
Site	= -4
Minimum quadrant elevation (2400 meters)	= 135

Elevation for range	
5800 meters	= 400
Site	= +3
Maximum QE	= 403

15-8. Safety Data for Shell ICM

a. The deflection limits for shell ICM are determined in the same manner as those for shell HE. The range safety card includes special buffer zones required for firing shell ICM.

b. To determine the minimum quadrant elevation—

(1) Enter the range to impact column in the TFT addendum and determine the lowest listed range to impact that just exceeds the minimum safe range.

(2) Extract the appropriate correction factor and HE quadrant elevation value corresponding to the range to impact determined above.

(3) Add the HE quadrant elevation value

(4) *Minimum FS—fuze M564.*
Fuze setting corresponding
to minimum elevation
(el 139) = 8.5

(5) *Minimum FS—fuze M514.*

Time of flight corresponding to corrected minimum elevation (el 114)	= 7.3
Plus 5.5 seconds	5.5
Total	= 12.8
Minimum FS—fuze M514	= 13.0

(6) *Maximum quadrant elevation—range 5000.*

and the correction factor determined above to the site for shell HE determined in the normal manner at minimum range.

c. Use the M564 fuze setting corresponding to the minimum range for fuze time from either the GFT or the TFT as the minimum fuze setting.

d. To determine the maximum quadrant elevation—

(1) Enter the range to impact column and determine the maximum range to impact listed that does not exceed the maximum safe range.

(2) Extract the appropriate correction factor and the HE quadrant elevation value corresponding to that range.

(3) Add the HE quadrant elevation value and the correction factor determined above to the site for shell HE determined in the normal manner at maximum range.

FOR WEAPONS WHOSE ICM FIRING TABLES DO NOT CONTAIN RANGE-TO-IMPACT DATA—

MIN QE IS DETERMINED BY ENTERING TABLE A, COLUMN 1, WITH THE HE MIN QE (OR NEAREST LISTED VALUE), EXTRACTING THE CORRECTION FACTOR, AND ADDING IT TO THE HE MIN QE.

MAX QE IS THE HE MAXIMUM QE.

15-9. Safety Data for High-Angle Fire

The safety diagram for high-angle fire is computed in the the same general manner as that for low-angle fire except for the peculiarities created by the trajectory of high-angle fire. The exceptions are as follows:

a. Deflection.

(1) Prior to registration. The deflection limits for high-angle fire are computed in the same manner as those for low-angle fire, except that the limits are modified by the large amount of drift peculiar to high-angle fire. The left deflection limit is moved to the left by the amount of the minimum high-angle drift for the charges to be fired within

the range limits. The right deflection limit is moved to the left by the amount of maximum drift for the charges to be fired within the range limits. The values for minimum and maximum drift are obtained from the GFT. If the drift value is not listed on the GFT for the ranges (minimum and maximum) listed on the safety card, the nearest value in the TFT is used.

(2) After high-angle registration. The deflection limits for high-angle fire are computed in the same manner as those for low-angle fire and are further modified as noted in (1) above. Since the elevation will change after registration, drift must be recomputed. Registration corrections for charges 1 through 4 can be transferred to any other of charges 1 through 5; however, corrections for charge 5 and above apply only to the charge registered.

b. Quadrant elevation.

(1) Prior to registration. The minimum and maximum quadrants for high-angle fire are handled in the same manner as those for low-angle fire except for the computation of site. The 10-mil site factor from the GFT is used, and the angle of site is computed to the nearest whole mil from the GST by use of the M-gagepoint.

(2) After high-angle registration. The firing of missions throughout the safety limits usually will require more than one charge; therefore, the minimum and maximum elevations are computed for each charge using the corrections determined for the charge registered. The minimum and maximum elevations for high-angle fire are computed in the same manner as those for low-angle fire. If a GFT is to be used, the minimum and maximum elevations are read under the manufacturer's hairline. Site must be recomputed by use of the 10-mil factor as described above.

c. Fuze settings. Minimum fuze settings are not computed for high-angle fire. Mechanical time fuzes should not be used due to excessive probable errors in height of burst. For safety in firing high-angle with fuze VT, the FDO must insure a safe target plot and correct computation of fuze setting.

15-10. Safety Data for Shell Smoke (WP, HC, and Colored)

a. The weight of all projectiles is usually stamped on the projectile in terms of so many squares ($\square$). Each caliber HE projectile has a designated standard $\square$ weight. The standards are listed in the introduction to the appropriate TFT. The TFT data is based on the standard weight projectile. Therefore, any time we are firing a projectile that is ballistically matched with the HE projectile but of a different square weight, we must correct for this difference.

b. The WP, HC, and colored smoke projectiles are ballistically matched to the HE projectile, but often differ in weight. The FDO computes the basic safety data in the same manner as for shell HE with the exception of minimum and maximum quadrant elevations. To determine the quadrant elevations, a correction factor for the difference in weight must be applied to the minimum and maximum ranges. For the minimum range:

(1) First, determine square weight difference.

(a) *Shell WP*. Given:

Shell WP, M110, weight 7 squares (7 $\square$).

Shell HE, M107, standard weight 4 squares (4 $\square$) from TFT.

Difference in square weights:

$$7 \square \text{ (WP)} - 4 \square \text{ (HE)} \\ = +3 \square \text{ (INCREASE of 3 } \square \text{)}$$

(b) *Shell HC*. Generally has the same standard square weight as HE.

If so, use HE safety data.

If there is a square weight difference, use the same procedures as for WP above.

(c) *Colored Smoke*. Given:

Colored smoke weight given in pounds, e.g., shell M116, weight 86.4 pounds.

Shell HE, M107, weight 95.0 pounds (standard).

From the introduction of the applicable TFT, find the weight per square ($\pm 1 \square = 1.1$ pounds).

Difference in square weights: 86.4 (weight shell colored smoke) - 95.0 (weight shell HE) = -8.6 pounds (DECREASE of 8.6).

$$\text{(weight difference)} \frac{8.6}{1.1} = 7.8 \\ \text{(from TFT)}$$

(Decrease of 8 $\square$)

(2) Next, enter table F of the appropriate TFT.

(a) At the nearest listed value to the minimum range, extract the unit correction factor for a projectile weight of 1 square (increase or decrease).

(b) Determine the correction by multiplying the difference in projectile weight (1) by the unit correction (2). Express to the nearest 10 meters.

(c) Apply the correction to the minimum range. Place the hairline of the GFT over the corrected range and read the elevation under the hairline. Add HE site at original range to the elevation to find the minimum QE.

EXAMPLE:

Given:

Shell WP, fuze M564

Min rg 2400 meters

Charge 4 GB

Weight of HE projectile = 4 squares

Weight of WP projectile = 7 squares

Difference in weights of projectiles = +3 squares

Weight of projectile unit correction (range 2400 M from TFT) = +21 meters

Range correction:

$$(+21 \times +3 \square = +63 \text{ or } 60) = +60 \text{ meters}$$

Corrected range (2400 + 60) = 2460 meters

Elevation (range 2460) (GFT) = 130 mils

Site (range 2400) = -4 mils

Min QE = 126 mils

c. Minimum safe fuze setting for M564 will

be read under the manufacturer's hairline corresponding to the corrected range; e.g., corrected range 2460 = 8.1 seconds. For fuzes in the M520A1 family, such as M501 MT fuze, the correction factor from the TFT must be applied to the M564 FS determined from the GFT.

d. To determine the maximum QE:

(1) Repeat b(2)(a) above using the maximum range.

(2) Repeat b(2)(b) above.

(3) Apply the correction to the maximum range. Place the hairline of the GFT over the corrected range and read the elevation. Add HE site at the original range to this elevation to find the maximum QE.

NOTE: IF A REGISTRATION HAS BEEN CONDUCTED, THE ELEVATION AND M564 FUZE SETTING SHOULD BE READ UNDER THE APPROPRIATE GAGE-LINES OF THE GFT SETTING.

15-11. Safety Data for Shell Illuminating

a. General. When the illuminating projectile is to be employed, the FDO computes the basic safety data in the same manner as for shell HE with the exception of minimum and maximum quadrant elevations. Whenever possible the illuminating graphical firing tables (GFT) should be used to compute safety data. This may not always be possible, since range limits may fall off the applicable GFT. In this case safety data must be computed with the tabular firing tables (TFT).

b. Illuminating safety data computed with the GFT.

(1) To determine the minimum quadrant elevation using the illuminating GFT—

(a) Place the manufacturer's hairline over the minimum range (time range line as appropriate).

(b) Under the hairline, read the minimum elevation on the "elevation to impact" scale. Add the HE site at that range

to the elevation. The result is the illuminating minimum quadrant elevation.

(2) The M564 fuze setting corresponding to the range used in (1)(a) above for shell HE is valid for shell illuminating and can be read from the HE GFT.

(3) To determine the maximum quadrant elevation using the illuminating GFT—

(a) Place the manufacturer's hairline over the maximum range.

(b) Under the hairline, read the maximum elevation on the "elevation to impact" scale. Add the HE site at maximum range to the elevation. The result is the illuminating maximum quadrant elevation.

c. Illuminating safety data computed with the TFT.

(1) To determine the minimum quadrant elevation—

(a) Enter the tabular firing tables (TFT) with the minimum range and determine the corresponding elevation and the change in elevation necessary for a 50-meter change in height of burst.

(b) Compare the battery altitude to the maximum altitude at minimum range and express the vertical interval (VI) to the nearest 50 meters.

(c) Subtract the VI from 750 and divide this quantity by 50 to determine the number of 50-meter increments necessary to move the burst of the round to the ground.

(d) Multiply the number of increments by the change in elevation determined previously and subtract this amount from the elevation corresponding to the minimum range. The result, expressed to the nearest mil, is the minimum QE.

(e) Minimum time is the M564 fuze setting corresponding to minimum range (read under the time gage line on the HE GFT).

(2) To determine the maximum quadrant elevation—

(a) Enter the range-to-impact column of the TFT with the maximum range or the

next lower listed range. Express the QE corresponding to this range to the nearest mil.

(b) Apply site computed for HE to the result. This is the maximum QE.

(3) The following is an illustration of the procedure for computing minimum and maximum QE and minimum fuze setting for a 155-mm howitzer M109A1, charge 5 white bag, shell illuminating M485A2. The minimum range is 2,500 meters; the vertical interval to the highest point on the minimum range line is +70 meters. The maximum range is 8,000 meters; the HE site for the minimum altitude at that range is -21 mils.

Quadrant elevation for range
2500 meters (includes
750-meter HOB) = 406.2 mils

Vertical interval (+70
expressed to the nearest
50 meters) = 50 meters

Height-of-burst correction
for down 700 (14 increments
of 50 meters $\times$ 18.7 (elevation
change for 50 meters)) = 261.8 mils

Minimum QE (406.2 - 261.8
= 144.4) = 144 mils

M564 fuze setting corresponding to range 2500
(minimum time for shell
HE is valid for shell illum) = 7.2

15-12. Miscellaneous

a. Direct fire. When direct fire is employed, the computation of safety data is the same as that prescribed for low-angle firing. For range, even though firing is conducted by use of the range scale on the direct fire telescope, the safety officer must verify the elevation to insure that rounds fired will be safe. In order to do this, the safety officer must verify safety settings by using the gunner's quadrant or the elevation scale to insure that rounds are not fired below minimum quadrant elevation or above maximum quadrant elevation.

b. Heavy artillery. Because of the great range and resulting drift involved in firing the 175-mm gun, drift for low-angle fire *must* be included in the computation of safety limits prior to registration. Determine the drift for all charges being fired and apply the largest value to all deflection limits.



16-10. The Conduct Phase

a. Determining training to be conducted. During this phase, the commander must determine the training to be conducted, program the training, and then conduct the training.

(1) Ideally, the battery commander would select for training all of the performance objectives he previously determined during the analysis phase. This probably will not be possible, so he should consider available resources and focus on the objectives that make the greatest contribution to accomplishment of the unit mission. He can do this by using the following three-phase process:

(a) Establish training priorities. The performance objectives for which training is needed should be ranked in the order of their contribution to mission readiness. This listing must reflect guidance on priorities established by higher headquarters as well as judgment of the battery commander. The following might assist in establishing priorities:

The battery commander should insure that his unit can accomplish the fundamental objectives (ARTEP level 3) before undertaking the more difficult performance objectives (level 2) and then the most difficult (level 1).

Within a given ARTEP level, the training objectives designated by an asterisk (*) should be accomplished before the other objectives. The asterisk designates mandatory training objectives for a given training level.

(b) Estimate training resources. The time, personnel, equipment, and training areas required to meet each of these performance objectives should be realistically estimated.

(c) Allocate available training resources. The resources available to support training should be allocated in accordance with the established priorities.

(2) There are three obvious benefits to be derived from this three-phase process.

(a) First, by having done his "homework," the battery commander can justify his needs for additional resources and can address the mission impact if his requests are denied.

(b) Second, the process will surface any misunderstandings as to the relative priorities for the unit's various tactical and administrative missions. If the emphasis is incorrect, it should become apparent in the response from higher headquarters to requests for training support.

(c) Third, it provides higher headquarters a rational basis for allocating its training resources to subordinate units.

(3) This process is crucial to development of a training program. It can mean the difference between satisfaction and frustration when the commander is dealing with a higher headquarters on matters related to training priorities and support.

b. Programing training.

(1) In the previous steps, the battery commander determines and schedules the performance objectives selected for training. He programs these performance objectives on the basis of:

(a) When the required resources (firing ranges, local training areas, ammunition, etc.) will become available.

(b) A logical sequence of conducting training from easier to more difficult tasks.

(2) Failure to schedule and program carefully *well in advance* can cause problems for both the trainer and the soldiers. The principal documents used by the cannon battery to program and schedule training are the training forecast and the weekly training schedule. The training forecast is any type of calendar device used to indicate the performance objective to be taught each day, the time to be devoted to each, and any training directed by higher headquarters. It is the primary reference in the preparation of the weekly training schedule and normally covers a quarterly period. Long-range planning depicted in the training forecast is general in nature. However, within 1 month of the conduct of training, the forecast should

become fairly specific (performance objective, time, and references should be included).

(3) An important part of scheduling training is the selection and notification of the trainers. Trainers should be alerted *as far in advance as possible* to give them maximum time for adequate preparation. To assist them, the battery commander/training officer should provide them with complete training guidance as described in FM 21-6.

c. Conducting training.

(1) The quality of the steps already completed in this system will be revealed clearly during the conduct of training. The common focus of all previous steps is the battery, section, or individual training objective selected for training. The task, condition, and standard of the PERFORMANCE OBJECTIVE defines the conduct of training. Training should consist of problems and exercises that are designed to insure that the soldier, section, or battery can accomplish the training objective.

(2) FM 21-6, *How to Prepare and Conduct Military Training*, was developed for trainers. It guides the trainer through a step-by-step process for preparing and conducting training. Using FM 21-6 as a general guide and using the tips presented in chapter 17 of this manual, trainers should be able to conduct meaningful performance-oriented training.

(3) Remember that *performance evaluation* is a vital part of the conduct of each training session. It provides the battery commander with continuous feedback on learning achieved. This feedback, in turn, provides valuable information and data for revising the current training program.

16-11. Evaluating Training

a. Evaluating training is simply an up-to-

date report of where your unit is now in training. Specifically, the commander is making another determination of whether the various individual, section, or battery training objectives can be met.

b. One basis for this determination should be the performance evaluation conducted during each training session. The battery commander is then insuring that he has reached the training level he had set out to reach. If he has not successfully attained his goals, he begins the training cycle again with the new input from his evaluation. If he has accomplished his goals, he renews the cycle at the next higher level of training. Again, much of this is accomplished subjectively as an inherent part of performance-oriented training.

16-12. Summary

a. Figure 16-2 is a summary of training at the battery level. It shows the relationship between individual-, section-, and battery-level training and the training literature that should be used in conjunction with each step.

b. A warning, however, is in order. Figure 16-2 is a simplified model that attempts to explain a very complex problem—training in the hostile training environment. There are few, if any, batteries that have all individuals and sections at the same level of training. For example, a cannon battery commander might find that three of his howitzer sections need to undergo individual training/evaluations (phase I), the other three howitzer sections and the FDC are conducting section training/evaluations (phase II), and the battery commander is conducting a certain amount of battery-level training (phase III). This multi-echelon approach to training recognizes that a strict training cycle in which all sections are at the same training level at the same point in time is a rarity. However, a battery commander should be able to fit each of his *sections* into one of the phases depicted in the figure.

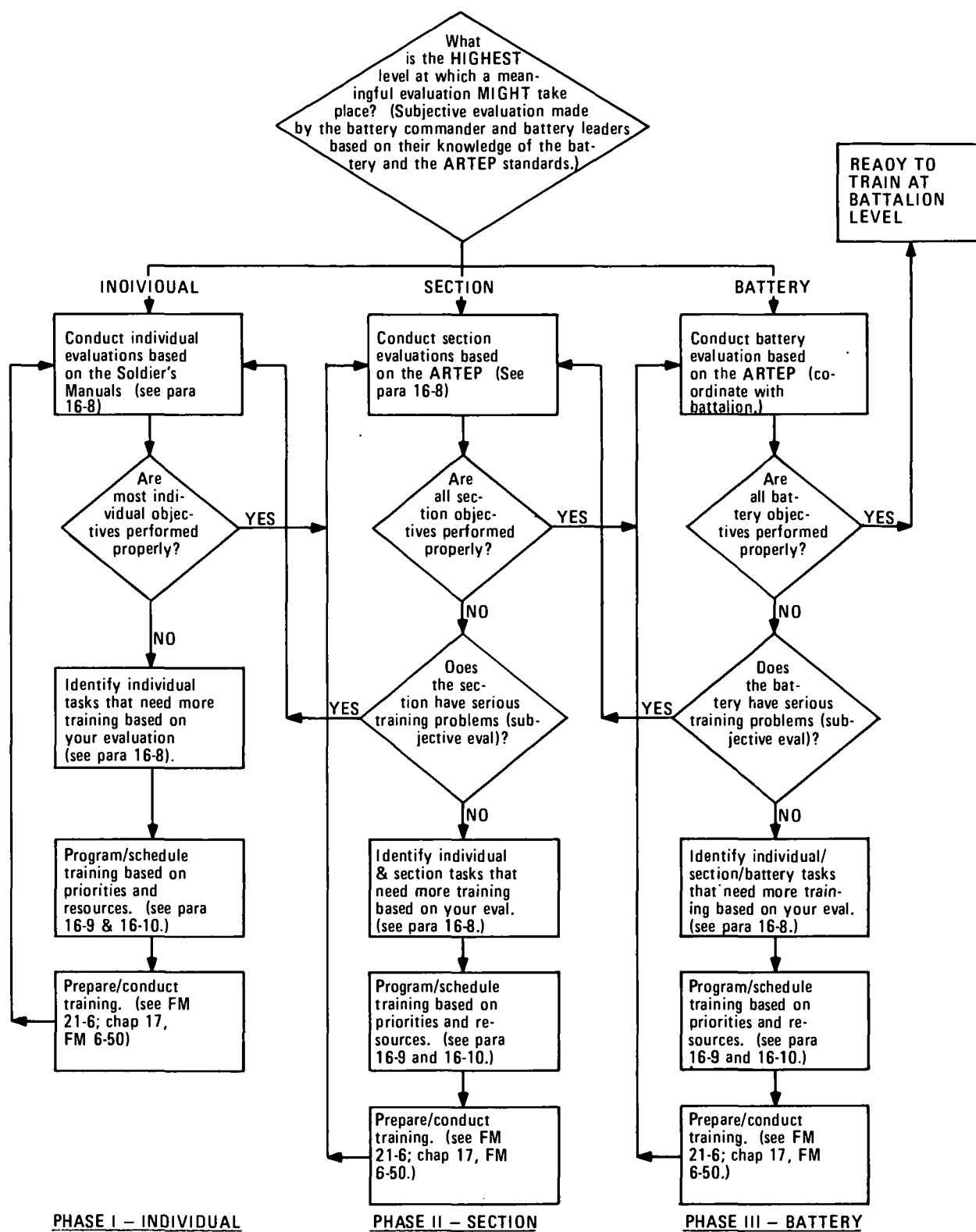


Figure 16-2. Battery-level training cycle model.



references, and explains the standards that must be met for evaluation (SQT). *The soldier cannot be promoted unless he qualifies for award of the next higher skill level.* These individual tasks, when taken collectively, form the ARTEP objectives.

d. Any training program must take into account the interaction of individual and collective training as well as the need to conduct both concurrently. This is a part of a multi-echeloned approach to training at several levels simultaneously—section, battery, and battalion.

16-4. Training Publications

The following is a list of those key training publications that form the basis for any battery training program. These publications must be understood and used by all supervisors involved with training or training management.

a. The *Army Training and Evaluation Program* for the unit.

b. The *soldier's manuals* and *commander's manual* for all unit MOSs.

c. The *operator's manual* and *field manual* for the unit's type of howitzer or gun. (Eventually, the 6-series FMs will be rescinded as their content is merged into "user's manual" TMs.)

d. FM 6-40-5, *Modern Battlefield Cannon Gunnery*.

e. FM 6-50, *The Field Artillery Cannon Battery*.

f. FM 21-6, *How to Prepare and Conduct Military Training*.

g. TC 21-5-7, *Training Management in Battalions*.

The purpose of these publications will be discussed throughout part four of this manual.

Section II. PERFORMANCE-ORIENTED TRAINING

16-5. General

To understand how the ARTEP should be used in the development of a training program and the preparation and conduct of training, it is necessary to understand the performance-oriented training philosophy. Performance-oriented training focuses on those critical tasks that prepare soldiers for combat. It must guide both training managers as they develop training programs and trainers as they prepare for and conduct training. Unfortunately, this concept of training is frequently only a concept. Many times, commanders and soldiers have witnessed training that has little or no relation to job performance. Such training wastes the limited training resources available and often adversely affects the morale and motivation of the soldiers. Therefore, *the crucial first step is to recognize the purpose of training—preparation for combat.* Once this idea becomes ingrained, both training managers and trainers can proceed with the development of training that serves the needs of the unit and the soldiers being trained.

16-6. Performance-Oriented Training Objectives

a. The key to effective training is the development of performance-oriented training objectives. These objectives facilitate clear and concise thinking about training for combat. This is due to their nature and structure. These objectives must contain a precise statement of the *task* to be performed, the *condition(s)* under which the task is performed, and the *training standard(s)* of acceptable performance.

b. This structure is much different from traditional training objectives, which are vague and hard to measure. For example, it has long been common practice to write a training objective such as the following:

Traditional Training Objective

"To insure that each howitzer section is proficient in the conduct of indirect fire missions."

In contrast, a performance-oriented training objective for the same skill might read as follows:

Performance-Oriented Training Objective

TASK: Each M109A1 howitzer section will conduct indirect fire missions.

CONDITIONS: The battery FDC has announced a fire mission.

STANDARDS:

The howitzer is ready to fire within 30 seconds after receipt of QE for the initial round.

The howitzer is ready to fire within 20 seconds after receipt of QE for subsequent rounds.

The bubbles on the elevation quadrant and panoramic telescope are centered prior to firing.

The correct deflection, QE, fuze, fuze setting, projectile, and propellant are used.

c. The development of these performance-oriented training objectives takes a lot of thought and effort! However, there are some valuable payoffs from this process. These payoffs are described in terms of the training and evaluation equation:

Training Objective = Training + Evaluation

In other words, a precisely written training objective—that actually outlines task, conditions, and standards—is the evaluation for that training.

d. Moreover, the whole training process is governed by the detailed performance objective. With objectives stated in precise terms, one is less likely to waste training time. *The principle of the training and evaluation equation is that we teach and train for the realities of combat.* This is

sometimes a difficult concept for people to understand. Perhaps this issue can best be clarified by reference to nonmilitary activities. Take the case of the football or basketball team preparing for a game. In effect, the coach teaches and trains to win the game. He does this by developing a playbook, which clearly defines tasks (the plays) that he wants his team to perform. He establishes appropriate conditions and standards for his practice (training) sessions. Similarly, the ARTEP can be thought of as the commander's playbook. By specifying in performance terms what the battalion, battery, and sections must be capable of doing, the ARTEP provides the basis for developing training programs and includes much of the information that the trainers need to prepare for and conduct better combat training.

It is important to remember that inherent in the conduct of performance-oriented training is an evaluation. When a howitzer section, for example, is conducting training on a particular ARTEP training objective and they achieve the published standard, they have in effect been evaluated. Personally monitoring ongoing training and receiving reports from subordinates will help keep the commander aware of current training status without dedicating his limited resources to an evaluation or a test. Also, the commander should be aware that training proficiency is very perishable. Evaluation and revision of the unit training program must be a continuous affair.

Section III. DEVELOPING THE TRAINING PROGRAM

16-7. General

a. TC 21-5-7, *Training Management in Battalions*, has been written specifically for training managers. It describes a four-step process (fig 16-1) that explains how to develop training programs and amplifies the training philosophy upon which the process is based. This publication should be used in

conjunction with the ARTEP and soldier's manuals to develop the battery training program.

b. The four-step process is a logical process to follow in selecting training goals, planning for the conduct of training to achieve these goals, and insuring that the training is properly supported. Also, it shows when to

evaluate the results of training and permits adjustment of the program to better achieve

training goals. In a diagram, the process of training management looks like this:

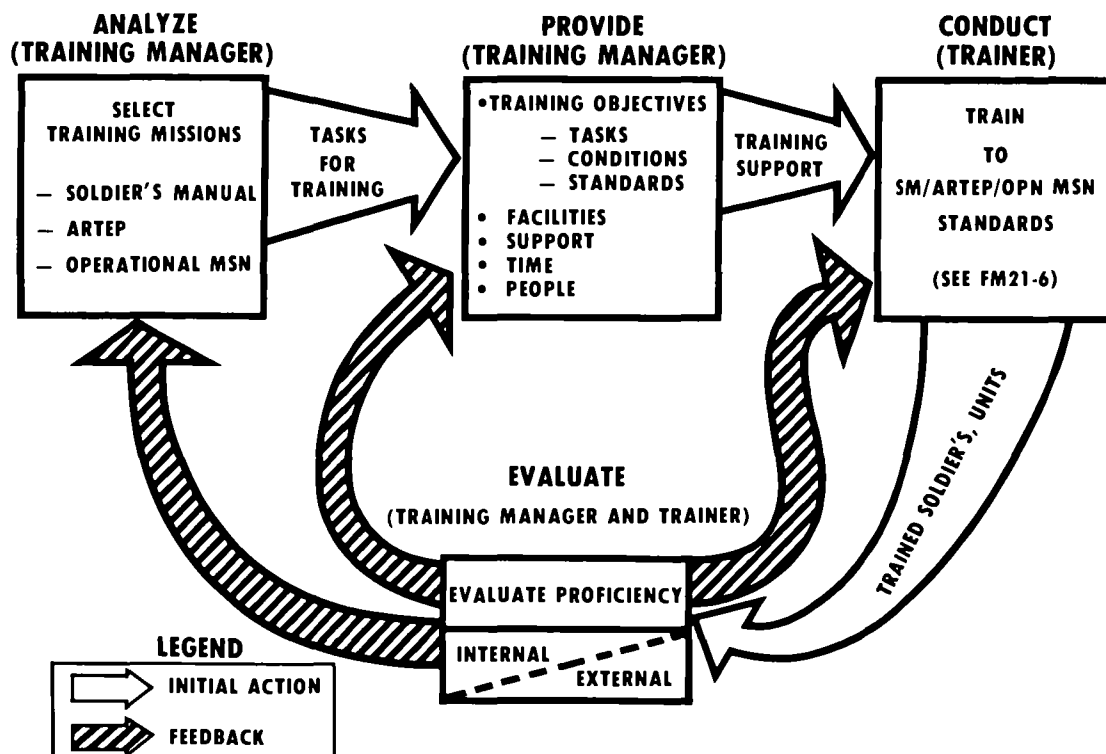


Figure 16-1. The four-step training process.

c. This scheme involves only the application of common sense and can be followed without difficulty by anybody in a unit. It must be understood that the training process is never finished. As the diagram indicates, training management is a *continuous* process. At battery level, it depends on "cut and fit" methods, on trial and error in matching what the commander wants to do with what the unit has the time and other resources to accomplish. Every time a unit receives a new mission, or has a significant change in its personnel, or conducts an evaluation that reveals a need for additional training, its training program will have to be adjusted. The objective is to *build and sustain readiness in the unit to perform its assigned missions—readiness of individuals, readiness of sections, and readiness of the battery as a unit.*

16-8. Training Program Analysis

During this phase you must determine where your unit should be in terms of training, where it really is now, and what training is needed to get from "really is" to "should be."

a. *Determining where your unit should go in training.* This step will guide the battery commander toward establishing individual and unit performance objectives that, if attained, will insure his battery's ability to satisfactorily perform its assigned mission. This requires the development of the same type of performance-oriented training objectives as those contained in the ARTEP. Their development provides the answers to this question: "Where should the battery and its sections be with respect to performing successfully in combat?" For example, the indirect firing objective discussed in

paragraph 16-6 is one of the training objectives contained in ARTEP 6-365. It describes one of the fundamental combat capabilities required of howitzer sections. By using the ARTEP as a source document for section and battery training objectives, the battery commander will find that the ARTEP has largely completed this step and that the development of the unit's training program can proceed.

b. Determining where your unit is now in training.

(1) The next step in the analysis phase is for the battery commander to determine the current level of individual and unit proficiency in the training objectives previously identified. Ideally, the battery commander would conduct a realistic live-fire field training exercise (FTX) at battery level, based on the ARTEP, to make this determination. In most batteries, however, the training resources to conduct battery-level FTXs ("dry" or "wet") are not available. In such cases, subjective evaluations of the current battery proficiency might be made by examining past performance results and consulting with battery officers and NCOs as to the training proficiency of their sections. If a more objective field evaluation *can* be done—do it!

(2) Many good commanders lack confidence in the information received from subjective evaluations. Even though it might be impossible for them to conduct a battery-level diagnostic field evaluation, it is certainly within the capability of an imaginative battery commander to conduct *section-level* diagnostic field evaluations. Since the ARTEP lists critical section tasks, which, when taken collectively, equal battery-level ARTEP tasks, evaluating/training sections on the basis of the ARTEP section training objectives would be the *next best thing* to evaluating the entire battery. These section-level diagnostic evaluations can serve as the basis for the unit training program in garrison during those periods when resources preclude the battery going to the field.

(3) Let's briefly look at how the battery commander and his subordinate leaders can

do this with limited training resources. The following methods can be employed in conducting evaluations of the cannon battery elements:

(a) Since the cannon section evaluation (app C) is based on the howitzer section training/evaluation outlines in the ARTEP, it does not require live ammunition and can be administered in a restricted local training area. It permits the battery commander to determine the strengths and weaknesses of an entire section (see chapter 17 for a more detailed discussion of training and evaluating cannon sections).

(b) An evaluation using the *M31 field artillery trainer* has limited value for evaluating cannon crews. It can be extremely effective in the evaluation of FO and FDC sections (see chapter 13 of FM 6-40-5 for details).

(c) A fire direction center evaluation should be based on the ARTEP. A complete evaluation of the FDC can be accomplished easily by adapting the firing battery headquarters training/evaluation outlines into a tactical scenario. All that is needed (in addition to the FDC's TOE equipment) is an area large enough for the FDC and "canned" missions/situations fed into FDC over wire or radio by an evaluator.

(4) In some cases, the battery's state of training and resources might make it difficult to conduct pretraining diagnostic evaluations even at the section level. The battery commander and battery leaders should then conduct pretraining evaluations at the *individual* level. These evaluations should be based on the tasks listed in the *soldier's manual*. The individual training objectives listed in the soldier's manuals are critical combat tasks, which, when taken collectively, equal section-level ARTEP tasks. So, evaluating/training individuals on the basis of SM training objectives would be the next best thing to evaluating each section on the basis of the ARTEP training objectives. The soldier's manual could be used as the source for creating a series of performance-oriented test stations. The number and organization of the test stations would depend on the MOS of the soldiers

CHAPTER 17

BATTERY TRAINING TECHNIQUES

Section I. INTRODUCTION

17-1. General

a. The previous chapter presented brief explanations of the Army training system, the performance-oriented approach to training, and the training management process. It was written primarily for the battery commander, who—with the battalion commander—must plan, organize, conduct, evaluate, and supervise the training of his battery, using the ARTEP and soldier's manuals as his guides.

b. This chapter will present various techniques that might be used by the battery commander and *his trainers* (battery officers/NCOs) to prepare and conduct training in the most effective and efficient manner. The discussion in this chapter is geared primarily toward the training of the battery's sections, excluding the fire direction center. The training of these personnel is covered in FM 6-40-5.

17-2. The Trainer's Role

a. FM 21-6, *How to Prepare and Conduct Military Training*, was developed for trainers. It was designed to be used with TC 21-5-7, *Training Management in Battalions*, the soldier's manuals, and the ARTEP. FM 21-6 describes a three-step backward planning process that trainers should use to prepare and conduct training. These steps are:

Step 1: Describe the Desired Results of Training

Step 2: Prepare to Conduct Training

Step 3: Conduct Training to Standards

b. In step 1, the trainer obtains the battery commander's training guidance, describing precisely what the soldier must be able to do at the completion of training (the commander's training objective is based on the ARTEP/SM). This guidance should also

tell the trainer to whom the training will be given, when and where the training will take place, and why the commander decided that training was needed. If the commander's guidance is incomplete, the trainer must develop this information himself, using FM 21-6, the SMs, and the ARTEP.

c. In step 2, the trainer develops, if necessary, those intermediate training objectives that will make the training logical and progressive. This is important when the commander's training objective is complex in nature (e.g., the indirect fire mission objective discussed in paragraph 16-6). Next, the trainer organizes training by determining the order in which intermediate objectives are taught and by estimating the required resources.

d. In step 3, the trainer actually conducts the training to insure the soldiers meet the training standards established in the commander's objective. In conducting performance-oriented training, the trainer must make every effort to hold lectures and conferences to a minimum. The majority of training time must be devoted to hands-on training. This performance-oriented approach lends itself to a training session (a class or a block of instruction) consisting of three phases:

PHASE I: The trainer states the purpose of the training and explains or demonstrates how the task will be performed. This part should be as brief as possible.

PHASE II: The soldiers practice the task under close supervision to acquire the degree of proficiency required by the training standard.

PHASE III. The soldiers are tested by performing the task to the established training standard. Those who meet the standards can proceed to another activity; those who do not should be critiqued on

mistakes, should continue practicing, and should be reevaluated.

e. FM 21-6 discusses the three-step backward planning process in detail, with examples showing how it applies to individual and collective training. This chapter will not repeat the detail of FM 21-6 but will present additional training techniques for the battery to supplement the training process presented in FM 21-6.

NOTE

The remainder of this chapter is divided into the following sections:

Section II addresses how to train *sections* in the battery with emphasis on howitzer section training.

Section III addresses the training of *individuals* who normally do not participate in collective section training and training in common individual skills.

Section IV presents some *battery-level* training techniques for molding the various battery sections into a battery team.

Section II. SECTION TRAINING IN THE BATTERY

17-3. General

a. The objectives of section training are to—

- (1) Train individuals in their principal duties,
- (2) Train the section as a team, and
- (3) Cross-train individuals in the various duties within the section.

b. The section chiefs are the principal trainers in the battery during the conduct of section training. By insuring that each section chief is qualified to do his job, the battery commander takes a big first step in developing effective section training (see paragraph 17-10).

c. Even though AR 350-1 does not require any formal record of individual or section training in the firing battery, some system should be established to record the training progress of each soldier and each section in the battery. However, care should be taken to prevent the administrative portion of

training from becoming a burden.

(1) Each section chief could use a notebook in which he keeps an informal daily record of training conducted, individuals present for instruction, performance objectives accomplished, deficient areas noted, and any other remarks concerning the training of his section. These records should be examined regularly by the XO, CFB, and GSG to help them evaluate training and program future activities.

(2) The soldier's manual and job book are excellent tools for noncommissioned officers or other first-line supervisors in maintaining a record of each soldier's progressive achievements in individual training. The job book is a pocket-sized pamphlet. It lists the critical tasks from the soldier's manual for each man's duty position and has columns for the entry of the results of the soldier's most recent evaluation on each task. The *pencil* entry is made on a "GO" or "NO GO" basis with the date and the initials of the trainer.

each person at a skill level one step above his present duty position. For example, each 13B10 is evaluated on the tasks identified in the soldier's manual for the gunner and each 13B20 is evaluated on the tasks shown for the section chief. Since these evaluations are progressive in nature, the evaluation results identify those tasks needing training at the skill level tested and at lower skill levels. The XO/CFB/GSG are then identifying new skills needed to be taught and old skills that still need refreshing. The section chief prepares and conducts training on the basis of the results of these individual evaluations (see paragraph 17-6).

d. Some form of section drill is another tried method available to the XO, CFB, GSG, and section chief to promote cross-training within a section. Section drill, as shown in the appropriate 6-series weapon field manual, can be useful as a training tool to familiarize all section members with the various section duties, especially during emplacement and march order of the weapon. However, the XO/CFB/GSG should realize that section drill can quickly become monotonous and boring and does not drill all individual skills requiring cross-training.

e. In the long run, the individual soldier also must become personally involved in his own cross-training and skill progression. Never before has the individual soldier had so much quality training literature and so many training devices to assist in his own training. *The primary tool the individual soldier has is his own copy of the soldier's manual.* It is designed to help the soldier train himself. In this manual is a training and evaluation outline for each task the individual is required to master. Each training and evaluation outline states what he must be able to do (task), the equipment he needs to perform the task (conditions), how well he must be able to do the task (standards), the best method for performing the task (training steps), and references to help teach the task in detail. The soldier can use this manual in conjunction with TEC lessons and correspondence courses to build his own proficiency in his present and next higher skill levels. The commander can be of assistance in this effort by insuring that each

individual has the proper manual and knows precisely what it contains and how to use it. See section IV for additional details on conducting and monitoring decentralized individual training.

17-8. Training an Ammunition Section

a. The primary mission of the battery ammunition section is the transport and delivery of ammunition. The training of this section should focus on the tasks related to this mission: driving, ammunition handling and storage, maintenance of ammunition and ammunition vehicles, map reading, RTO procedures, etc. The ammunition section chief initially should be concerned with training all his section personnel to become proficient wheeled vehicle drivers. Since driving is such a major portion of the ammunition section mission, the battery commander should be very hesitant to assign an individual to the ammunition section who is incapable of, or unmotivated toward, becoming a qualified driver. Paragraph 18-4 offers guidance on operator training and supervision and should be referred to by the XO, CFB, and ammunition section chief in setting up this very important first part of the ammunition section training program.

b. The XO/CFB/GSG must bear in mind that the ammunition section members must maintain proficiency in their 13B duties. This could be done by assigning each ammunition section member to a parent cannon section for garrison training. The ammunition personnel should train side-by-side with the cannon personnel when not engaged with more critical ammunition section training. During field training, each member could perform the duties of a cannoneer in his parent cannon section after performing his ammunition section duties. The battery ammunition sergeant could sometimes serve as acting chief of section during the absence of any regular cannon chief of section.

c. Since a battery ammunition section normally has only a few personnel, the use of TEC lessons and correspondence courses in conjunction with the soldier's manual is a very effective teaching vehicle for training the ammunition section.

17-9. Preparing Soldiers for the 13B Skill Qualification Test (SQT)

The skill qualification test (SQT) is a performance-oriented individual evaluation (replacing the MOS test) the individual soldier is required to take to validate his proficiency at his present skill level. The introduction to the 13B soldier's manual gives the soldier an excellent description of the composition of the SQT and how to prepare for it. The following important point should be made to the BC, XO, CFB, GSG, and section chiefs concerning SQT preparation:

The soldier's manual is the basis for the SQT. All the training techniques recommended in the previous four paragraphs are based upon the soldier's manual. By following these techniques (or your own unique techniques based on the soldier's manual) you will eliminate the need for a period of frantic preparation prior to the SQT. In addition, the soldier's perception will be that his battery's training program is geared to help him meet the requirements of the Enlisted Personnel Management System—and *he will conclude that his training is meaningful.*

17-10. Preparing Cannon Section Chiefs to be Firing Battery Trainers

a. The section chief is the primary trainer in the cannon battery. The battery commander must be assured that a cannon section chief has the appropriate technical

expertise. The skill level 3 tasks in the soldier's manual can be used to help identify any weaknesses of the sections chiefs. The XO/CFB/GSG can then set up a training program to teach the needed skills.

b. Once minimum proficiency is attained, a system must be established to insure that all section chiefs maintain proficiency in their duties and prepare themselves for the next higher grade. One of the best methods to increase the MOS proficiency of a section chief and to help him advance in his career is to prepare an individual training program based on correspondence courses and/or the 13B soldier's manual. Paragraphs 17-12 and 17-13 describe how to conduct and monitor such programs.

c. Besides maintaining the appropriate job skills needed to be a firing battery trainer, *the cannon section chief must be able to prepare and conduct training properly.* While many section chiefs have received some formal training in methods of military instruction, many of them have not received training in how to prepare and conduct performance-oriented training in accordance with the concepts and procedures emphasized in FM 21-6 and the tasks identified in chapter 8 of FM 6-13B3. To remedy this, appendix F of FM 21-6 contains complete guidance on the training of trainers, to include lesson plans and a list of training aids needed. By using appendix E of FM 21-6 and chapter 8 of FM 6-13B3, commanders can insure that their NCOs have the fundamental skills necessary to handle performance-oriented training sessions.

Section III. INDIVIDUAL TRAINING IN THE BATTERY

17-11. General

Section II of this chapter presented some techniques for training MOS 13B personnel (and referred the reader to FM 6-40-5 for the training of MOS 13E personnel). In the battery, these personnel normally train and function as a group under the supervision of their chief of section, GSG, CFB, AXO, or XO. The mission of the individuals in the battery

headquarters and communications section is mostly day-to-day support of the entire battery. Normally, these personnel do not participate in collective training except for battery-level field exercises and mandatory personal knowledge classes. Therefore, it is most practicable to set up an individual OJT (on-the-job training) program for these individuals who must actively support the battery during most garrison training and

great deal more time with the battery leaders than would be possible if the entire unit were present.

17-17. Command Post Exercise

a. The second step in this recommended training sequence is a command post exercise (CPX). A CPX is a tactical exercise for the command, communications, and fire direction personnel of a unit. The purpose of a CPX is to permit leaders at all levels to go through the command and control procedures involved in a firing battery operation in the same manner as they would in an FTX or in combat. It is recommended that the following personnel take part in a firing battery CPX.

- (1) The BC and 1SG with vehicle.
- (2) The XO or CFB/GSG with vehicle.
- (3) A fire support team (FIST) with all TOE equipment (provided by battalion).
- (4) The entire FDC and BOC with all TOE equipment.
- (5) The entire communications section with all TOE equipment.

b. The battery commander should develop a scenario that calls for the initiation of fire missions, displacement, and reports similar to those listed in the appropriate ARTEP. The value of a CPX is that it can be accomplished in about one-third of the time it would take for a full-scale exercise. The CPX will help surface procedural errors, communications problems, and unfamiliarity with the battery field SOP. A fast-moving scenario is the key to a good CPX. Actions should be initiated according to how the situations are presented and how the different sections react. The battery commander may interrupt at times to offer a critique. The duration of the exercise depends on its value in the eyes of the battery commander. At the conclusion of the CPX, all participants should gather to discuss the exercise.

17-18. Advance Party Rehearsals and Emplacement Drills

a. Rehearsal for the advance party is the next logical step in our sequence. The training and organization of the advance

party is discussed in chapter 3. The battery commander should make the rehearsal as realistic as possible—as though it were the real thing. Rehearsals should include preparation of cannon positions, selection of alternate and supplementary positions, determination of the track plan, emplacement of route markers, and guiding of simulated cannons into position. These rehearsals can be the key to a smooth occupation during all subsequent tactical exercises.

b. While the battery commander is conducting rehearsals for the advance party, the XO and CFB might profit by conducting emplacement drills for the remainder of the battery. Such drills can help save valuable time and prevent damage to equipment during future field exercises. Also these drills provide a means of insuring that all components of stored equipment are present and serviceable. These drills might include emplacement of such things as:

- (1) Tents,
- (2) Camouflage nets,
- (3) Cannon section installations,
- (4) The RC-292 antenna,
- (5) Generator sets,
- (6) A portable latrine, and
- (7) Immersion heaters.

c. These drills can be interesting training exercises, especially when competition is built in by the battery leaders.

17-19. The M31 Field Artillery Trainer

The M31 (14.5-mm) trainer can be used effectively in the initial phases of the combined training of cannon crews, fire direction personnel, and FIST observers. Together with specially designed FADAC tapes and graphical equipment, the M31 system allows realistic fire direction center computations, good ground observation practice, and total system integration at nominal cost. By using the M31 at this point in the training sequence, the battery can make a preliminary evaluation of the performance of the firing battery team (FIST-

FDC-cannon) and correct faults without utilizing expensive service ammunition. (See TM 9-6920-361-13&P on the employment of the M31 and FM 6-40-5 for more details on training with the M31.)

17-20. Command Post Exercise with Base Piece

a. The final preparatory step in our sequence leading up to a firing battery FTX is a CPX with base piece. The CPX with base piece is a live firing exercise involving only one cannon section. The following personnel participate in addition to those discussed in paragraph 17-17:

(1) Base piece section.

(2) One gun guide from each nonparticipating cannon section.

(3) Support personnel (maintenance, ammunition, supply, mess) as designated by the battery commander.

b. A complete real-time scenario for this base piece CPX can be established directly from the ARTEP. The unit can then undergo a mini-FTX of all missions established in the ARTEP while using only about 50 percent of the ammunition required for a full-scale firing battery ARTEP. Most of the same problems that would have occurred in a full FTX will surface.

17-21. Field Training Exercise (FTX)

A full-scale firing battery FTX should be the highlight of any battery-level training sequence.

a. A well-conducted field exercise offers the battery commander two well-defined products. First, it demonstrates the ability of the entire unit to perform under simulated combat conditions and identifies training requirements for future training. Second, it offers a test of those skills and techniques taught during previous exercises.

b. Successful conduct of a field exercise depends upon a complete scenario based on the ARTEP and good control by battery leaders or higher headquarters.

c. The FTX should be conducted under

complete tactical conditions so that the commander will not waste his time and that of his men. The commander should allow the battery headquarters to take full part in the tactical play. All TOE equipment should be taken to the field. This exercise is one of the best vehicles the commander has at his disposal for practicing the many aspects of the unit field SOP.

d. It is nearly impossible to keep all members of the battery gainfully employed during the conduct of an FTX; therefore, the battery commander must give consideration to concurrent training before going out on an FTX. The commander should give priority to those subjects that cannot be thoroughly learned in a garrison-type environment, such as setting fuzes, storage of ammunition, recovery of vehicles, construction of field fortifications, and cross-country driving.

e. The battery commander must also give careful consideration to the post-FTX recovery period. Plans for this should be made *before* the FTX.

Battery-level training can use the following successive steps in approaching complete mission readiness:

Tactical exercise without troops (TEWT).

Command post exercise (CPX).

Advance party rehearsals and emplacement drills.

M31 (14.5-mm) trainer exercise.

Command post exercise with base piece.

Field training exercise (FTX).

17-22. Summary

The success of the field artillery cannon battery on the battlefield will depend heavily on the maintenance of its weapon systems and the superiority of its tactics and techniques. Of even more importance will be the *proficiency of individual soldiers, sections, and batteries*. The weapons and tactics of the cannon battery will be effective

CHAPTER 18

MAINTENANCE PROCEDURES AND TRAINING

18-1. General

a. Preventive maintenance (PM) is the heart and soul of the entire maintenance system. The commander should bear in mind that maintenance repairs and services cost dollars—his OMA funds. Excessive maintenance results in high operating and funding costs. Inadequate maintenance leads to premature breakdowns and failures, which result in excessive downtime and, in turn, high operating costs.

b. The basic Army mission dictates a requirement for every soldier to perform proper preventive maintenance on his equipment. On the battlefield units likely will be operating alone or unsupported for undetermined periods of time and under a wide variety of terrain and weather conditions. Obviously, there is much interdependence of men and equipment that must be coordinated to sustain a combat capability under varying degrees of isolation. The time consumed in awaiting the arrival of a maintenance support team or in evacuating an unserviceable item for repairs may mean the difference between mission success and failure.

c. The primary objectives of maintenance, in accordance with the principles set forth in AR 750-1, are to achieve maximum conservation by preventive maintenance of equipment, to reduce replacement requirements through the conversion of unserviceable materiel to a serviceable status, and to insure maximum use of supplies and equipment in the hands of using personnel. Thus, the commander must relate to his own maintenance program the seven factors that influence maintenance. These factors are:

FACTORS AFFECTING MAINTENANCE

Repair parts

Tools and test equipment

Time

Facilities

Personnel

Publications

Command

18-2. Responsibilities and Functions

It is true that preventive maintenance is the job of every individual. There are, however, different types and degrees of responsibilities and functions. The effectiveness of the PM program depends upon a realistic appraisal of the duties and responsibilities of the various members of the battery.

a. Role of the commander. For the most part, the commander in the PM program is concerned with four areas—policy, standards, inspections, and enforcement.

(1) *Policy.* As with other activities, success is often dependent on the troops' understanding of what is wanted and who is responsible for getting it done. The commander's policy can best be disseminated through a maintenance standing operating procedure (SOP). The SOP should outline or specify maintenance procedures, fix responsibility, and indicate where coordination is necessary. A good SOP is complete but concise. A lengthy and overly detailed SOP may well be ignored.

(2) *Standards.* The commander must set the maintenance standards. He must insure that the maintenance effort is oriented toward logistic readiness instead of "eyewash." Too many times a commander will leave a motor pool of clean, neatly aligned vehicles or a maintenance shop camouflaged with clean tools, records, and supply manuals without knowing that 20 percent of his equipment will not operate!

(3) *Inspection.* Inspection is the key to an effective PM program. The commander must conduct *frequent* and *systematic* inspections to insure that his maintenance standards are achieved. The informal

command inspection is by far the best means for obtaining maintenance information. Although the reports of subordinates should enable the commander to judge the results of his policy and directives, there is no substitute for the commander's *personal* estimate of the situation.

(4) *Enforcement.* Although the battery officers and NCOs are responsible for keeping the commander informed, they are not empowered to take formal corrective action. Enforcement of the maintenance policy lies with the commander, and he alone has the authority to direct compliance with published directives. One of the most common mistakes made in maintenance is to blame the technician for failure when the real blame lies in an area beyond his control.

b. Role of the executive officer. The executive officer (XO) should be the battery officer responsible for the unit's preventive maintenance program. He, in turn, should assign specific responsibilities to other personnel and insure their coordinated effort.

(1) The battery executive officer, accompanied by the chief of firing battery and the field artillery mechanic(s), should make spot-check inspections. He should inspect different parts of the weapons and motor carriages (or prime movers) each day to insure complete coverage every few days.

(2) The XO should make a periodic, thorough mechanical inspection of weapons, motor carriages (prime movers), auxiliary equipment, tools, and spare parts.

c. Role of the chief of firing battery/gunnery sergeant. Under the supervision of the battery XO, the chief of firing battery/gunnery sergeant is responsible for the logistic readiness of the battery's weapons and supporting equipment.

(1) He will keep the battery commander and XO informed concerning the efficiency of maintenance training and operation and the maintenance status of the battery's weapon systems and supporting equipment.

(2) He will insure that the section chiefs assign maintenance responsibilities to

individual members of the crew in performing the necessary inspections and maintenance of section vehicles and equipment. When a section is reduced in strength, he will insure that the section chief reassigns duties to see that all maintenance is performed.

(3) He will analyze the materiel readiness condition of the weapon systems and supporting equipment daily. He should know the expected delivery date for all repair parts on request for deadlined equipment and insure followup action is taken when a part is not received on time.

(4) He should insure, when possible, that deadlining parts are installed by battery maintenance or the FA mechanic prior to close of the duty day.

(5) He should require section chiefs to inventory basic issue items (BII) after each field exercise, or at least monthly.

(6) He assists the commander and XO in making informal and formal command inspections, and inspects vehicles and equipment periodically to insure that records are being maintained properly and that maintenance and repair work performed by the battery shop conforms to established standards. He makes recommendations to the commander for improvement as necessary.

(7) He supervises supply accountability for all weapon systems and keeps the XO informed of any tool shortages.

(8) He insures that sufficient publications are on hand to support the battery weapon systems and that all changes are posted.

d. Role of the technician. The battery commander has a noncommissioned officer specialist assigned as his technical adviser. The most common abuse of the technician is the tendency to blame him for maintenance failures, which implies a shifting of responsibility from the commander to his technicians. The technician must provide technical guidance, make recommendations concerning the preventive maintenance program, assist in the conduct of inspections,

and assist in the preparation and conduct of preventive maintenance training. He must *not* assume command responsibility.

e. Role of mechanics. All personnel who perform repairs and services on equipment, regardless of commodity group, are referred to as mechanics. They are the unit's last defense against multiplying maintenance problems.

(1) To be a mechanic worthy of the title, an individual must have the necessary technical training and must be fully qualified on the types, makes, and models of equipment he is expected to inspect, service, and repair. Putting a man in fatigues, issuing him a toolbox, and assigning him to a maintenance shop does not make him a mechanic!

(2) Maintenance personnel must be motivated to do excellent work with a minimum amount of supervision. The end product of a mechanic's labor frequently is not apparent to visual inspection; however, disastrous results may follow careless performance of a service, a repair job, or an inspection. It is essential that each equipment operator and crewman have confidence in the mechanic and in the quality of maintenance performed.

f. Role of the section chief. Chiefs of section are directly responsible for operator and crew maintenance.

(1) They insure that operators, assistant operators, and crewmembers—

(a) Perform the maintenance services, inspections, and repairs in accordance with the provisions of appropriate technical manuals.

(b) Listen and observe for abnormal equipment operation and record on DA Form 2404, Equipment Inspection and Maintenance Worksheet, all equipment faults that cannot be corrected.

(c) Clean and service equipment before putting it away.

(2) In addition, they must—

(a) Know the expected delivery date for all repair parts and inform the CFB/GSG of

all parts that are not received by the expected delivery date.

(b) Inventory basic issue items after each field exercise or at least monthly.

(c) Spot-check equipment every day for any needed repair or adjustment.

(d) Insure that all equipment publications (TMs, LOs) are available and all changes have been posted.

g. Role of the operator. The well-trained operator is the first line of defense against deteriorating equipment. If the commander can control the handling and operation of the equipment by the individual user and operator, he has found the key to prevention of equipment failures. Training and disciplining the operator so that he handles his equipment with "loving care" will reduce the commander's PM headaches.

18-3. How to Evaluate the PM Program

Normally, the first step a commander must take in evaluating his PM program is to review his existing organization. Are the portions of the overall job channeled to the appropriate elements within the unit? Is the unit responsive to available human, materiel, and time resources? Are the human resources properly organized? The commander must answer these fundamental questions. If the answer to any of them is *no*, then the commander must find the reason and correct whatever deficiency exists. At the outset, the commander must isolate any problems he may have. This is not always as easy as it sounds. Since the commander is not a specialist, he may have need of some outside sources to assist him in isolating his problems. Three sources are listed here.

a. Maintenance assistance and instruction team program. The purpose of the maintenance assistance and instruction team (MAIT) program is to emphasize maintenance and to provide commanders with the necessary tools for isolating maintenance problems and achieving a high state of readiness. The MAIT program emphasizes practical application and provides the individual soldier with a clearer

understanding of maintenance techniques and procedures. Although the commander currently may be enjoying a high state of preparedness and readiness, he should periodically—at least annually—call his local MAIT chief and arrange for a visit.

b. Logistic assistance program (AR 700-4). The objective of the supply and maintenance assistance program is to provide assistance to commanders in resolving those supply and maintenance problems that are beyond the commander's capabilities to resolve with organic resources. Supply and maintenance specialists are US Army military and Department of the Army civilian personnel qualified to give assistance in the following areas:

(1) Assisting unit commanders in identifying and resolving logistic problems.

(2) Furnishing guidance and assistance to commanders who are responsible for conducting training to improve the skills of individuals responsible for, or associated with, materiel readiness.

(3) Providing maintenance management assistance designed to improve the skills and increase the capability of unit personnel in The Army Maintenance Management System (TAMMS), in preparation of materiel readiness and unit readiness reports, and in associated supply and maintenance management subjects.

c. Technical assistance. Technical assistance is the act of providing instruction and technical guidance to supported units by a direct support maintenance battalion. Its objective is to insure the correct interpretation and uniform application of maintenance and maintenance supply procedures in order to improve operations and conserve materiel. The battery commander may contact his supporting maintenance unit and make informal arrangements for assistance from the supporting unit.

The importance of the continuous evaluation of the maintenance program by commanders cannot be overstressed. The more complex equipment becomes, the easier it is for personnel to overlook equipment faults. The need for maintenance and maintenance inspection becomes greater all the time. The older equipment becomes, the greater the need for command emphasis. **DON'T NEGLECT YOUR PROGRAM.**

18-4. Establishing an Effective PM Program

Sound organizational maintenance programs can reduce requirements for time-consuming and expensive repair and services at higher categories of maintenance. There is no rigid pattern for establishing a PM program, but the lack of detail in regulations is never an excuse for inaction. FM 29-2, *Organizational Maintenance Operations*, provides some excellent suggestions the commander may wish to use. The program established will vary with many factors and it should be changed as the situation changes. A typical approach is outlined below.

a. Organization. Organization is the first consideration in establishing an effective PM program. The commander states the mission and functions and assigns tasks to key personnel. Responsibilities are fixed such that preventive maintenance performed on the equipment is the responsibility of a specific individual—usually the section chief.

b. Training. Maintenance and operator skills must be commensurate with the equipment authorized for issue to a unit and with the demands made by mission requirements. The commander must make maximum use of soldier's manuals and ARTEPs. Skills at the organizational level must be somewhat broad in scope in order to

identify problems and to isolate and diagnose failures. Most organizations are not authorized, for example, a fuel and ignition specialist, an optics specialist, or an electrician.

(1) Any unit needs depth in skilled personnel such as vehicle operators, weapons repairmen, radio operators, and supply clerks. Some degree of functionalized cross-training to attain depth is always beneficial. For example, automotive personnel who can repair both vehicles and generators add depth to a unit's maintenance capability. Since skills are closely related to practice and association with operational equipment, emphasis should be placed on restoring the proficiency of operators and maintenance personnel after an extended period of equipment inoperability.

(2) Skill depth should be compatible with the organization's concept of tactical employment. Some skills must be developed within an organization to insure effective operation of the unit even though a necessary MOS is not authorized.

(3) In many cases, school-trained personnel and school quotas are not available. If courses scheduled by the Army school system (see DA Pam 351-4) are unavailable or inappropriate, the commander must establish a well-supervised on-the-job training (OJT) program. In support of OJT, most service schools offer correspondence/OJT courses with standards that closely parallel those of resident courses. These courses assist the commander in conducting OJT programs that will increase the materiel readiness of the unit and, at the same time, provide a means for maintenance personnel to become MOS-qualified and to progress to higher skill levels. Table I-1 (see appendix I) is a list of typical maintenance-related OJT programs and available correspondence courses.

(4) Many Department of the Army publications are available to assist commanders in training maintenance personnel. Some of these publications are useful as aids in establishing OJT programs; others are designed to assist commanders in establishing formal maintenance classes.

Table I-2 is a list of some of these publications.

c. Operator training and supervision. The operator is the key man in the entire PM program, and he must be trained to properly use and maintain his equipment. To qualify initially as an operator, a man must take a series of tests given by the local driver testing station and/or unit. The Department of the Army has a number of publications that set up the standard procedures for this initial selection and testing. These publications are listed in table I-3 and should be reviewed by all supervisors who control driver selection and training.

(1) The initial testing is a start point. Before a battery commander licenses an operator and assigns him to a vehicle, he should insure that the prospective driver understands all his responsibilities as an operator. In addition to the road test, there are many maintenance tasks that should be taught to the prospective driver before he is licensed. Many posts/units have schools that teach these additional operator tasks. In many cases, however, the commander will have to set up his own training program.

(2) Because of the continuing requirement to qualify new personnel as drivers, normally it is not practical to establish battery-level classes in these tasks. The section chief should be the individual responsible for teaching these tasks in an OJT-type program before recommending the licensing of an individual. Given the proper amount of time (normally about 2 weeks), a section chief should be able to qualify his operators in these tasks during the regular battery maintenance periods. Table I-4 is a *suggested* list of tasks (in an OJT program format) that might be used to train a driver before he is licensed. Some tasks obviously are not applicable to certain localities and should be disregarded.

(3) In some cases, the commander may feel that a more centralized battery-level effort is necessary. To aid in establishing his training program for operators, the commander/training officer might refer to the publications listed in table I-5 in addition to those listed in table I-3.

(4) Completing the driver training program and obtaining the SF 46 should be a challenge. The awarding of a driver's license indicates the battery commander's trust in the individual and the driver's acceptance of extra responsibilities. An imaginative commander will create rewards for those personnel willing to accept additional responsibilities. Such awards might include special passes and separate duty rosters for drivers (e.g., duty driver) and nondrivers (e.g., CQ runner and barracks orderly).

d. Time and scheduling. Army regulations require that commanders provide adequate time during duty hours for the performance of required preventive and corrective maintenance. Materiel readiness must be as important as personnel training and readiness. A proper balance must be maintained among training, maintenance, and all other requirements essential to combat readiness. Commanders must plan for the most efficient use of time available to individuals and to the unit as a whole. An organization's activities must be planned and organized to avoid haphazard use of maintenance time. The availability of personnel and their state of training must be considered in determining the time required and in allocating available time for maintenance application. Time means time for *training*, time for *inspections*, and time for *performance of maintenance*.

(1) *Time for equipment maintenance.* Time is one of the few constants that is a *must* in the maintenance effort. From accurate information on the number of man-hours devoted to maintenance, valid estimates can be made of the adequacy of many other factors that contribute to the total maintenance effort; e.g., skills, training, and facilities. The management of equipment maintenance costs can be related to the use of repair parts and man-hours expended in completing organizational repairs and services. It is worthy of note that the cost of Armywide maintenance efforts is assessed through determining man-hours recorded on maintenance records plus the dollar cost of repair parts derived from the number of repair parts used and their identification by national stock number (NSN). Therefore,

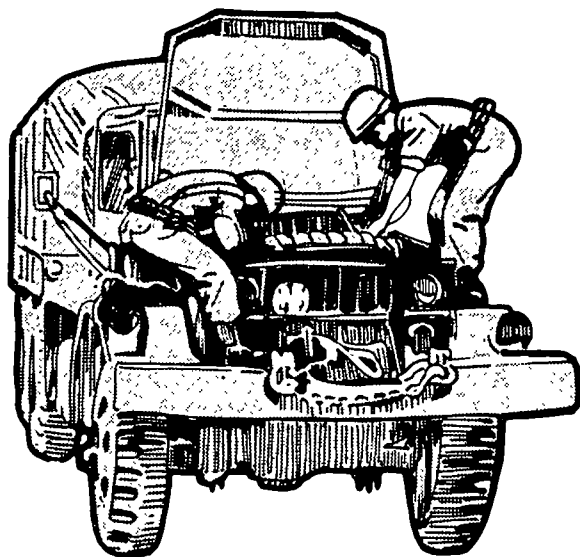
each commander and soldier working in the maintenance field should be impressed with the importance of accurately managing time consumed in the effort.

(a) *The training schedule* is one of the many tools the commander can use to emphasize equipment maintenance training. Training in maintenance—how it should be done—is important. The absence of maintenance periods from the training schedule will lead to emphasis on those scheduled subjects that do appear, with a resulting neglect of maintenance and logistical readiness. The commander also must consider equipment other than vehicles in scheduling maintenance periods. He must insure that his section chiefs develop priorities to equate the most important functions to the amount of time available. For example, priority should be given to maintenance of mission-essential materiel first. The second most important priority might be in maintaining non-mission-related items, and final consideration should be given to the maintenance of TA-50 equipment. Other subjects related to maintenance may be scheduled for personnel who have no direct responsibility for the equipment specified.

(b) Much time can be gained by properly integrating PM training into other unit activities. Two other *concurrent maintenance* areas that should concern the commander are the performance of maintenance by operators assigned to equipment as an in-addition-to duty and the performance of maintenance during road marches, tactical problems, and other field training. The commander's policy for each of these conditions can be adequately stated in the unit maintenance SOP. The absence of a stated policy on concurrent maintenance services and in-addition-to maintenance duties almost always will lead to equipment maintenance problems.

(c) *Making time available for operator services* provides an incentive for better preventive maintenance. Each job assigned an equipment operator should allow for the distance or hours of operation, permit inspections during the operational period,

and allow adequate time for after-operation services. A unit is asking for trouble if the end of an operational period runs into "chow time" too frequently. Time for at-halt inspections is essential for tactical and combat vehicles during a tactical march. Precautionary measures and performance indicators, which are important during equipment operation, *must* be stressed in operator training for all types of equipment.



(d) Each -20 technical manual and lubrication order for an item of equipment states the requirements for *periodic services*. The requirements may be given in terms of miles, hours, or a calendar period. A schedule will be prepared by the using unit for every item that requires a periodic service. DD Form 314, Preventive Maintenance Schedule and Record, is used for this purpose. The important management aspects of scheduled PM services are that they are completed on time and are performed according to the published instructions in the technical manual. The due dates and time allotted for these services must be controlled by supervisors in order to distribute workloads evenly for maintenance personnel.

(2) *Time for inspections.* Commanders must make time available for personal inspections. Also they should be aware of the maintenance man-hours being devoted to equipment inspections and the timing of inspections as they relate to other activities of

a unit. When the commander plans to conduct a personal inspection, he should consider what he wants to observe and the unit activity; for example, a unit mess that has just returned from a 10-day field training exercise (FTX) rarely will have its mess equipment prepared for inspection the following day. The commander should conduct his inspection after supervisors and noncommissioned officers have had a reasonable amount of time to get the equipment in shape. Commanders should make the best use of their own time by using PM indicators for equipment.

(3) *Priority of effort.* Progress is the keyword in any effort. Tasks should be assigned through the chain of command according to priorities that will achieve the most overall progress. Although the commander's estimate is a continuous process and decisions as to courses of action change frequently, an operator or mechanic should be permitted time and provided resources to complete one task before beginning another. Enough personnel and materiel resources should be concentrated on a course of action to insure its success.

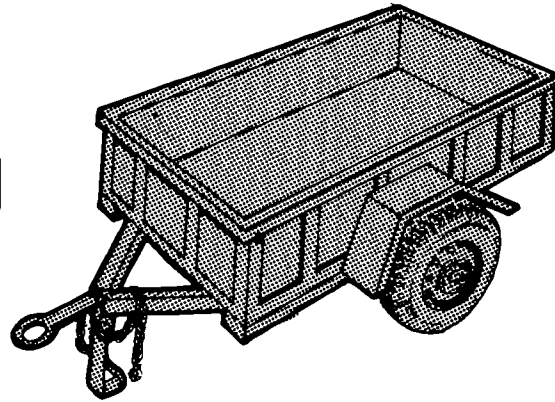
(a) The use of equipment serviceability criteria (ESC) can point up the types and categories of equipment that require concentration of effort. Equipment that falls into a RED classification should receive maintenance priority.

MAINTENANCE PRIORITIES

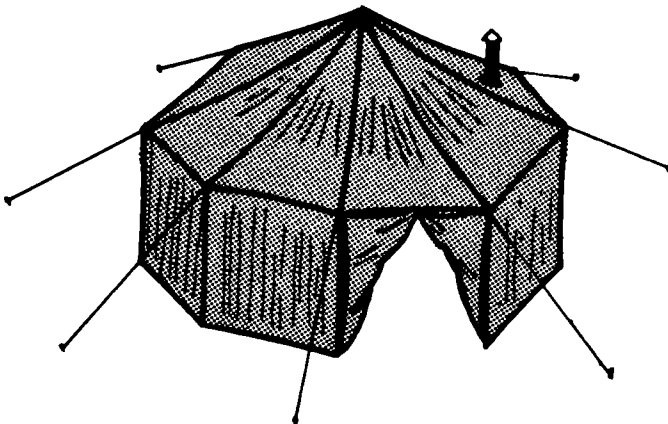
I



II



III



(b) Commanders must recognize that it is not realistic to expect every item of equipment to be available for use 100 percent of the time. If, after all requirements have been considered, there is just not enough time for complete maintenance, serious consideration should be given to placing some equipment in administrative storage. It will require maintenance services, but not as much as it would in active use. Proper care is part of the price that must be paid for the benefits derived from modern military equipment.

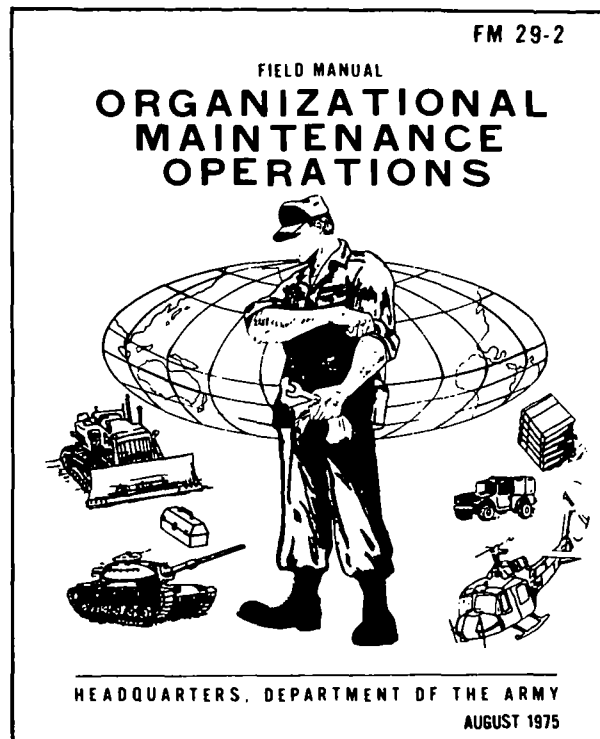
(4) *Identification of problem areas.* Forewarned is forearmed; therefore, problem areas must be identified before serious inroads can be made into the entire organizational maintenance program. The training schedule or even just the calendar—a projected field exercise or expected bad weather—can signal the advent of maintenance problems. Some examples of indicators that should warn a commander of problem areas are:

- (a) Low ratings in inspection reports.
- (b) Notable shortages or overages of repair parts and expendable supplies.
- (c) Accidents and frequent equipment failures.

e. Maintenance procedures. Sound, workable standing operating procedures are absolutely essential to the success of tactical operations and administrative and logistical procedures. SOPs are important to the success of organizational maintenance functions, whether the unit is in garrison or in the field.

(1) *Preparation of an SOP.* The preparation of an SOP or a change to an SOP requires planning and coordination within the organization. FM 29-2 has an excellent format for developing a unit SOP. An SOP should be prepared at each command level, including the battery. It should be printed in the most effective and convenient form and changed as necessary.

(2) *Delegation of authority.* Maintenance responsibilities and functions must be assigned. Each individual must know where



he functions in the overall plan; e.g., who is responsible for approving entries on DA Form 2408-14? The XO, the chief of firing battery, the motor sergeant—or all of them?

f. Repair parts supply operations. Specific repair parts requirements are generated by equipment failures and repair actions. The unit concerned is fortunate indeed if the necessary repair part is immediately available in the bin or on the shelf. The repair parts and common hardware that an organization should have on hand are those that are authorized to the unit and are needed most often to correct failures experienced in the unit. AR 710-2 governs supply procedures at the organizational level. Repair parts requirements are specific; the paperwork to obtain the parts is specific. Cyclic actions to process the paperwork must be followed in a routine order if supply procedures are to be responsive to unit needs.

(1) Interference with, or interruption of, supply routine and unit supply personnel must be kept to a minimum. Supply tasks are not difficult, but they are rigid and sometimes tedious and require the individual attention of supply personnel.

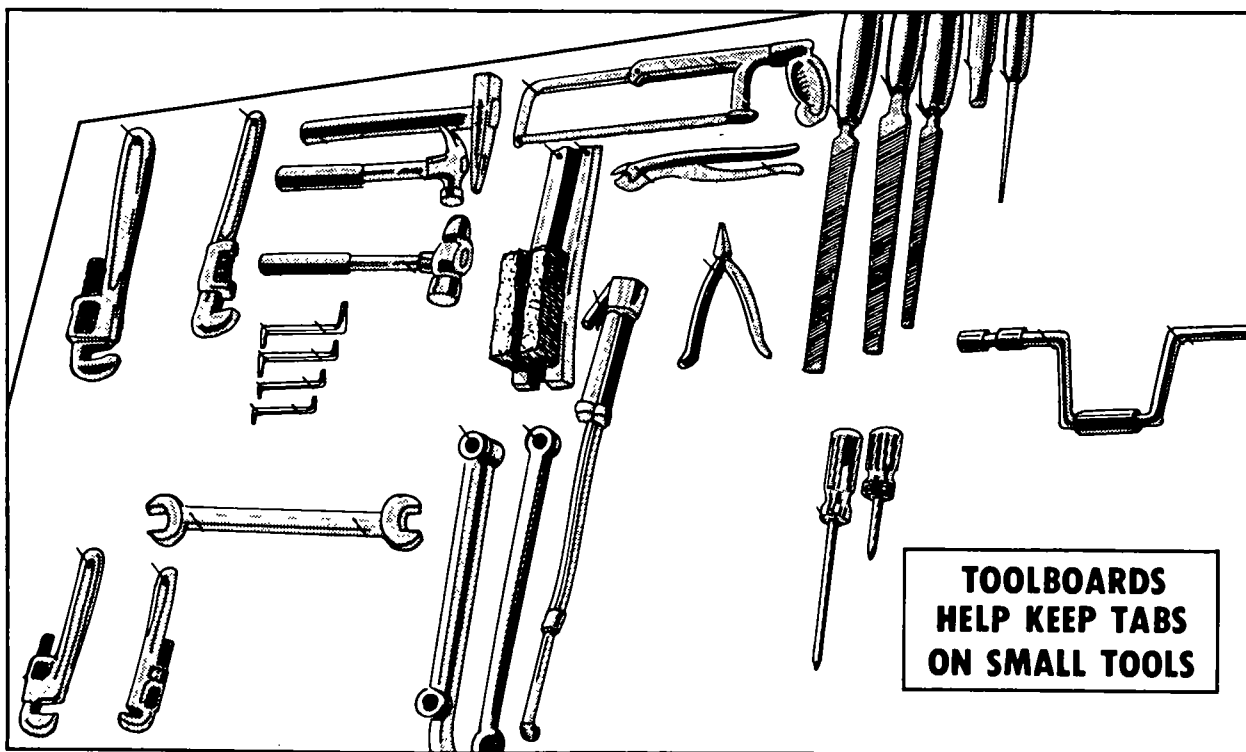
(2) Ignorance of published procedures is in fact an abuse of the supply system. Without a systematic routine, supply personnel will find many of their efforts unproductive, will receive excessive cancellations to requests, and will duplicate efforts unnecessarily.

g. Facilities and equipment. Effective maintenance requires the availability of adequate facilities. This means shelter, heat, light, and adequate power for the shop. Maintenance facilities available will vary depending upon the location and the activity. In garrison, maintenance personnel normally will have adequate facilities if the needs are explained and justified and requests for facilities are followed up. This sometimes requires ingenuity and imagination. One of the greatest deterrents to effective preventive maintenance is the lack of reasonably comfortable facilities. It is difficult to tighten and adjust equipment with cold fingers or to work in the dark. If conditions are not comfortable enough, maintenance may be performed improperly or left completely undone.

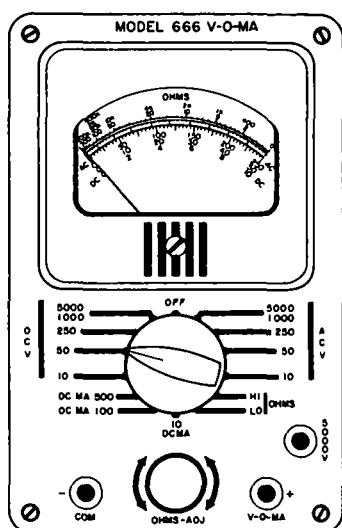
h. Tools and test equipment.

(1) Attempting to maintain equipment without the appropriate tools, repair parts, and facilities is both frustrating and nonproductive. The Army maintenance system provides the tools and test equipment necessary for performing the organizational maintenance mission. The completeness of tool sets is critical. Missing and defective tools often are the cause of ineffective or insufficient preventive maintenance. A system is needed for the control and assignment of tools and equipment, and there must be provisions for orderly stowage, protection, and availability of all tools and equipment. *PS Magazine* 292, March 1977, has an excellent article outlining these procedures. Detailed information on the care, preservation, and storage of tools and tool sets is published in technical manuals, technical bulletins, or supply bulletins. Each organization should refer to the list of publications under "tools" in current indexes. This will help to determine whether current, applicable publications are on hand for the tools and tool sets authorized.

(2) Organizational tool sets are designed for use by several mechanics. An organizational tool set that shows no signs of



normal wear probably is not being used. Normally, these tool sets contain items of test equipment that are authorized for checkout and diagnosis of equipment failures. Commanders inspecting maintenance shop operations should pay particular attention to the availability, calibration, and use of test equipment. The unit maintenance personnel should be queried on their familiarity with this test equipment. Tactical units should have provisions for orderly storage, protection, and availability of all tools in the field as well as in garrison.



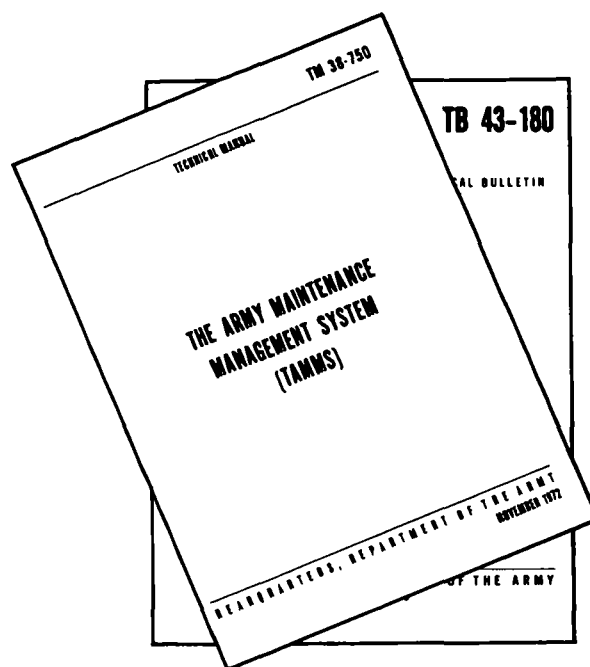
(3) With today's highly sophisticated equipment, calibrated test equipment is very important to the commander. TB 43-180, *Calibration Requirements for the Maintenance of Army Materiel*, is the "bible" for calibration—the single authoritative document for identification and establishment of calibration requirements—and is applicable to all US Army units. Chapter 6, TM 38-750, prescribes the forms and the "how to" of the calibration program.

i. Publications. The performance of maintenance, either preventive or corrective, on complex Army equipment depends on the prompt receipt of administrative and technical publications. No individual is expected to know the number and title of every publication pertaining to the equipment in his unit. However, it is necessary that everyone knows how to determine which publications are needed. A

knowledge of the publications system will help the commander insure that his unit is receiving proper publications distribution and support.

(1) Despite the effort and expense involved in the Army's vast publication system, there is a common failure to get publications into the hands of the user. Sometimes this failure can be blamed on the system itself, but more commonly it is a failure at organizational level to know what is required and to take the simple step of preparing a request (the commander should insure a copy of DA Pamphlet 310-10 is available for reference purposes). For this reason, each commander should, during unit inspections, check to determine whether the appropriate publications are available to the men who need them.

(2) Official DA publications that most directly affect organizational maintenance are regulations, circulars, field manuals, pamphlets of the 750-series, technical manuals, supply manuals, technical bulletins, lubrication orders, modification work orders, and supply catalogs.



(3) The commander must insure that the subscription forms of the DA Form 12 series (listed in table I-6) are completed by his unit to indicate the types of publications needed and

the quantities required to accomplish the unit mission.

(4) The more thought a unit gives to stating its requirements on the DA 12-series forms, the less work someone will have to do in requisitioning. If the unit's DA forms of the 12-series are correct, the publication officer or NCO will have little or no need to submit a DA Form 17 for ARs, FMs, etc. The unit will receive all needed publications automatically. Pinpoint distribution was created to relieve the unit of trying to keep up with new publications as they are issued and then requisitioning those items.

(5) Publications must be kept current. In accordance with AR 310-2, all organizations are required to review their existing subscription forms (12-series) periodically, at least twice a year and/or upon change of commanders. The review will be recorded, and review results will be filed at the unit and attached to DA Form 12 record copies.

(6) Each battery should maintain a

library of current publications for ready reference purposes by all personnel in the unit. Some consideration should be given to the number of libraries required to support the unit mission. A library of current maintenance publications required by operators and maintenance personnel must be maintained in the battery shop. Consideration may be given to establishing an MOS-related library in the training room. Paragraph I-5 is a suggested list of publications required by a battery maintenance section.

(7) *PS Magazine* is a pocket-size, cartoon-type magazine published monthly by DA for the information of organizational maintenance/supply personnel. It is clearly written in informal, everyday language and is a valuable source of information pertaining to preventive maintenance.

(8) DA Pamphlet 750-1 is a *must* for every commander. Chapter 1 is concerned with the philosophy of maintenance, and the remainder of the pamphlet contains

EQUIPMENT, SUPPLY PUBS (To St. Louis)	
DA FORM	
12	Establish Account
12-21	Supply Catalogs
12-21A	Instruction Sheet for 12-25 series
12-25	Supply Support Equipment
12-25A	Mobility Support Equipment
12-25B	Construction Equipment
12-25C	Environmental Equip.
12-25D	Electrical Gen. Rel., Marine, Amphib
12-25E	Chemical Equipment
12-26	Ordnance Disposal
12-28	Aviation, Avionic Configuration
12-29	Aviation, Rocket, Air Defense Fire Dir. Sys
12-31	Missile, Rocket
12-32	Supply Bulletins
12-34	Technical Bulletins
12-34A	Non Equipment TM's
12-34B	Nuclear Weapons
12-34C	Instruction Sheet for 12-36A
12-35	Avionics Equipment
12-36	Avionics Equipment
12-36A	Combat Vehicles
12-37	Trucks
12-38	Dolls, Trailer, Semi-trailer
12-39	Artillery, Small Arms and Conventional Ammo
12-40	Sighting and Fire Control Equipment
12-41	COMSEC Equipment
12-43	Radio, Fixed Radio Equipment
12-50	Field Radio Equipment
12-51	

ADMINISTRATIVE, TRAINING PUBS (To Baltimore)	
DA FORM	
12	Establish Account
12-4	Admin except Reqs, Circulars
12-5	Periodicals
12-8	Alfred Communication, Joint Army, Navy, Air Force
12-9A	Reqs, Circulars, Pam
12-9B	Reqs, Circulars, Pam
12-11	Instruction Sheet for 12-11 series
12-11A	Doctrinal (FM)
12-11B	Doctrinal (FM)
12-12	T (L, Tnd Pubs)



illustrations of PM indicators for common items of equipment.

j. Maintenance records and reports. Maintenance records and reports are needed for information and management purposes. The action taken, based on records or reports, is intended to benefit each equipment user and the entire PM program.

k. Inspections. Continuous observation of the PM program is required. This may be considered a matter of supervision or a matter of inspections; however, everybody must be constantly on the lookout for practices and conditions that help or hinder the program.

(1) Operators inspect the equipment on a continuing basis.

(2) Section chiefs inspect both the equipment and the operator to insure that proper tools and methods are being used to secure the best possible results. They provide advice and assistance as needed.

(3) Unit commanders inspect procedures to insure that personnel are following the

SOP and that desired results are being achieved. Officers cannot be expected to be completely knowledgeable in the detailed operation of the equipment, but they must be able to recognize satisfactory performance and maintenance through PM indicators. They should be particularly critical of the Preventive Maintenance Schedule and Record, DD Form 314, to insure that "paper maintenance" is not being performed. Officers should prepare themselves before inspections in order to insure that a thorough inspection of the unit will be made.

18-5. Using Key Personnel to Implement the PM Program

It is true the commander is responsible for all matters relating to mission accomplishment, discipline, training, welfare, and control of the men in his unit. He must supervise and insure timely completion of all battery activities, including providing command guidance to the motor officer, directing implementation of the maintenance program, and supervising the execution of the program. However, the commander who does not take into consideration the proper use of key personnel is being nearsighted, and his maintenance program will eventually suffer. Listed below are some tasks key personnel must perform to insure an effective PM program.

a. Executive officer/motor officer.

(1) Plans and implements the battery maintenance program.

(2) Advises the commander on the status of the maintenance program.

(3) Recommends solutions to identified maintenance problems.

(4) Makes changes as directed by the commander.

(5) Schedules ESC evaluations per SOP and local regulations.

(6) Assists commander in monitoring the performance of ESC evaluations.

(7) Supervises/prepares DA Form 2406, Materiel Readiness Report (Accumulative), as a feeder report.

(8) Analyzes DA Form 2406, Materiel Readiness Report, and briefs the commander.

(9) Insures pinpoint account (DA Form 12-series) is reviewed every 6 months and the results are on file.

(10) Analyzes the maintenance program in accordance with paragraph 4-3, FM 29-2.

b. Chief of firing battery/gunnery sergeant.

(1) Advises XO on problems affecting the maintenance program.

(2) Provides planning recommendations to XO on the allocation of all resources.

(3) Insures that crewmembers are available for scheduled services.

(4) Recommends maintenance standards to support mission accomplishment.

(5) Assists the XO in the execution of the section operator/crew maintenance program.

(6) Insures the availability of needed expendable supplies to support the operator/crew program.

(7) Insures cannon sections comply with the unit SOP.

(8) Supervises the cannon section maintenance program.

(9) Maintains cannon section equipment status report.

(10) Insures that cannon section operators are trained and licensed properly.

(11) Coordinates with battery motor sergeant on section maintenance problems.

(12) Insures DA Form 2408-4, Weapon Record Data, is closed out properly and forwarded in accordance with TM 38-750.

(13) Insures a new DA Form 2408-4, Weapon Record Data, is initiated prior to forwarding the old form.

c. Motor sergeant.

(1) Under supervision of the motor officer, implements the unit maintenance program.

(2) Advises the motor officer on the unit maintenance program and mechanic training.

(3) Conducts MOS refresher training for maintenance personnel.

(4) Executes changes as directed by motor officer.

(5) Verifies faults reported by operator/crew personnel.

(6) Determines cause of failure, if possible, and recommends corrective action.

(7) Prepares and maintains an equipment status board.

(8) Prepares and maintains a daily workload schedule.

(9) Spot-checks operator/crew maintenance and reports deviations from standard to the commander.

(10) Inspects or supervises inspection of equipment to insure that proper PM services have been performed.

(11) Supervises diagnostic testing of procedures on unit equipment.

(12) Controls special tools and test equipment.

(13) Insures that maintenance personnel are thoroughly briefed on maintenance/safety SOP.

(14) Monitors driver training.

(15) Inventories common and special tool sets monthly.

(16) Inspects tools weekly.

(17) Coordinates with chief of firing battery daily.

(18) Insures timely evacuation of equipment.

d. Chief of section.

(1) Insures that assigned drivers and alternates are properly trained and licensed.

(2) Insures that proper TMs and forms are available with the equipment and that latest changes have been posted.

(3) Checks and reports to the chief of

firing battery the operational status of equipment.

(4) Knows when services and lubrications are due on equipment according to logbook and hours/miles of operation.

(5) Trains each crewmember in performance of before-, during-, and after-operation services.

(6) Supervises assigned crewmembers in performing before-, during-, and after-operation service in accordance with the equipment TM.

(7) Informs chief of firing battery of all uncorrected faults.

(8) Insures crewmembers adhere to maintenance/safety SOP.

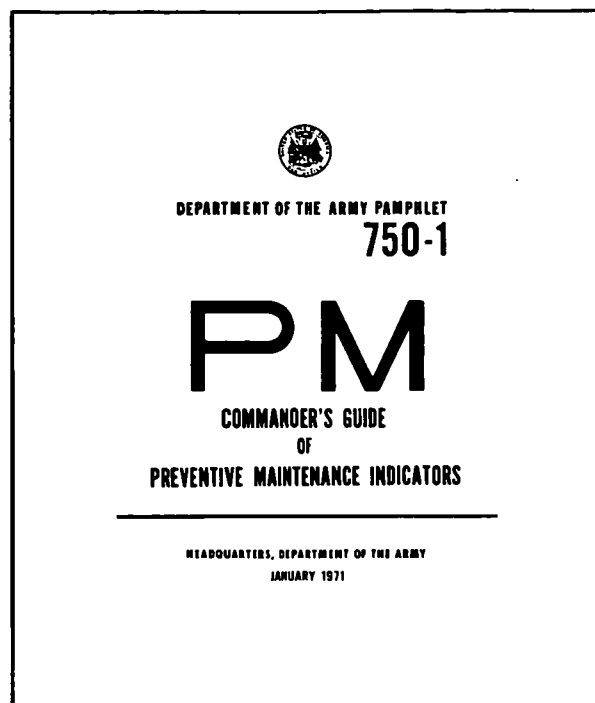
(9) Knows the expected delivery date for any repair part on request when his equipment is deadlined.

18-6. Using PM Indicators to Evaluate the PM Program

The term "PM indicator" is used to describe key features of personnel, materiel, supplies, procedures, and facilities, the known condition of which will indicate the quality of preventive maintenance. The formal definition of the term is "an area of possible failure or malfunction in equipment that can be detected by localized application of the sense of sight, sound, touch, or smell and indicates the condition and the quality of maintenance."

a. Selection of PM indicators. Prior to an inspection, a commander should determine which items of equipment or maintenance functions he is going to inspect. Using TMs, LOs, and other publications, he should then select two or three indicators for each item and become thoroughly familiar with them. This will develop a feeling of confidence and impress personnel of the inspected unit with his interest in maintenance. Different indicators for the same equipment should be selected for succeeding inspections so that personnel will not fall into the habit of maintaining only what they know will be inspected.

b. Use of PM indicators. The program of PM guides for commanders (DA Pam 750-1 and AR 750-1-2) has been established by the Department of the Army to provide consolidated preventive maintenance information for use by any commander. Preventive maintenance guides can assist the commander in estimating preventive maintenance requirements, in planning and managing a preventive maintenance program, in instructing subordinates, in scheduling and conducting inspections, and in *evaluating the effectiveness of the PM program*. During an inspection, commanders should always remember that the most important indicator is the item's performance and the probability that it will continue to perform satisfactorily based on the care it is receiving.



(1) Deficiencies found should be related to the cause.

(2) Elimination of the cause should be the commander's primary concern, since this will reduce that type of deficiency in the future.

(3) The source and cause most often can be found and corrected within the unit.

(4) If some outside (backup) support is the problem, command action may be required to relieve the problem.

c. General equipment PM indicators. Equipment PM indicators are, in most cases, detailed and specific and enable the commander to know precisely what to look for. However, in addition to specific equipment indicators, there are several PM indicators that may have a general application to many types and categories of equipment. The commander should be alert for evidence of the general indicators. The following fall into this category.

(1) *Adjustments.* Proper tolerances, clearance, and travel are required in many areas. Evidence of chafing, binding, cracking, rips or split seams, and erratic operation indicates improper adjustment. Frequently, improper adjustment may be quite evident in the amount of play in belts, pulleys, levers, or gears and in the amount of lateral movement that can be felt in bearing adjustment. Often, improper adjustment is quite apparent in such items as canvas and webbing.

(2) *Color and marking.* Bright colors are used in the areas of caution or safety. For example, yellow is used on the tips of aircraft propellers to warn personnel to keep clear. Black and yellow stripes are painted around grease pits to caution personnel. Decals and data plates contain very specific, purposeful information, and those that are missing or illegible should be replaced. Labels are important on many chemical and medical items, since discoloration may indicate deterioration. Discoloration of fabrics may indicate deterioration due to mildew, rot, acid burns, or just plain wear. Generally, color codes are applicable for various types of ammunition, high-pressure tubing, and electrical circuits. Certain areas, such as rubber tubing or lubricated metal surfaces, should never be painted.

(3) *Cleanliness.* Cleanliness, as related to maintenance, must be considered from the standpoint of its effect on the proper functioning of the equipment. Dirt may conceal deficiencies and shortcomings and result in further damage to the item.

Functional surfaces should be generally free of foreign matter so that cracks, dents, corrosion, or rust can be detected readily and will not interfere with the proper operation or function in such areas as metal-to-metal bearing surfaces, cooling surfaces, filters, or areas requiring lubrication. Fuel and lubricant leaks create safety hazards. The accumulation of foreign matter, grease, and oil cannot be tolerated in areas subject to fire. Cleanliness must be directly related to the environment in which equipment is used; e.g., the accumulation of rust is permissible in such areas as cannon tracks, mufflers, and exhausts. On the other hand, medical equipment must be sterile and must be free of stains and alkali deposits, and rubber must be free of oils, fats, and greases, which cause rapid deterioration. Although a clean piece of equipment is not necessarily well maintained, well-maintained equipment is always clean.

(4) *Equipment records.* Equipment records must be up to date, legible, and accurate and must indicate the true status of equipment. Outstanding MWOs, other deferred maintenance, and the number of uncorrected faults—along with the supply action and timely scheduling of maintenance—can be determined from equipment records as an indicator of an effective maintenance program.

(5) *Lubrication.* Lubrication orders should be on hand and in active use. No grittiness or binding should be evident in bearings or areas requiring lubrication. Grease fittings should be clean and clear, and the proper tools (such as purging tools and needle-nose adapters for flexible nozzle grease guns) should be on hand.

(6) *Safety features.* Compliance with commonsense safety requirements is a sound indicator of a good PM program. Fire extinguishers, emergency exits, and safety devices should be easily accessible and conspicuously marked. Containers for poisonous or flammable liquids must be isolated and properly labeled. Lacing wire, cotter pins, tang washers, safety pins, etc. should be present where needed and properly installed. Electrical grounding systems must

Positive, purposeful instruction, although the amount of time devoted may be limited, indicates a good training program.

(3) Ascertain the manner of task assignment. Teaming experienced skilled personnel with helpers or newly assigned men indicates planned efforts to raise skill levels.

(4) Observe work in progress for presence of operators or crews with equipment in organizational maintenance shops. Presence of operators and crews indicates emphasis on practical maintenance training and raising operator proficiency.

c. Shop organization and procedures.

(1) Examine procedures for scheduling and accepting equipment for services and repair. Determine whether there is a system of assigning work to mechanics. The supervisor of an efficient shop always should know the status of equipment in the shop and the amount of maintenance workload.

(2) Check the chain of command—a mechanic should not be required to take orders from more than one supervisor.

(3) Observe the processing of paperwork and flow of equipment records. Bottlenecks in paperwork indicate overcentralized administration. If equipment logs or maintenance worksheets that require entries by mechanics are not with the equipment when it is being repaired or serviced, duplication of paperwork or loss of maintenance information is indicated.

(4) Examine bins, stalls, or areas where repair parts are kept. These areas should provide adequate space for temporary storage. Parts should be easily identified and marked for a particular major item. Old dates of receipt (4 to 5 days) entered on shipping documents or parts to be installed indicate poor management, lack of personnel, or insufficient time for maintenance.

d. Tools and shop layout.

(1) Tool authorization documents for organizational, special, and individual sets and/or current lists of tools on hand, short, and on requisition indicate good shop

management. (Back issues of *PS Magazine* contain some very helpful illustrated lists.)

(2) A well-organized shop must make special tools and test equipment available to each mechanic, but the unit also must have a workable system for tool checkout, return, and safeguarding while tools are not in use. Shadow boards for tools indicate a shop concerned with tool care.

(3) Indicators of poor tool maintenance are loose wooden handles, broken screwdriver tips, mushroomed heads on drifts and chisels, lubricants on files, and broken or rounded-out wrenches.

(4) Shop layout depends largely on the geographic location or on buildings, rooms, and other physical facilities, such as grease pits (or racks) and wash areas. Work areas should be located to minimize interruption by outsiders. The main entrance should lead to the shop office or to the maintenance supervisor's desk if the shop is in one room.

(5) Indicators of a good shop layout are readily accessible technical publications, workbenches, lubricants, cleaning materials, electrical outlets, common hardware, tools, and trash cans. Temperature, lighting, and ventilation should be at least adequate.

e. Repair parts supply.

(1) If DA Forms 3318, Record of Demands-Title Insert, are maintained, examine five or six of them and note if authorized stockage is on hand or on order. Write down the NSN and on-hand quantity for each item. Compare the on-hand balances to quantities present in repair parts bins. Inspect for proper identification and storage to prevent damaging parts. Failure of quantities entered on records to agree with physical count or storage of unserviceable or damaged repair parts indicates poor repair parts management.

(2) Inspect the Document Register for Supply Actions (DA Form 2064) for entries approximately 30 days old showing parts requested and not yet received. Determine whether the parts are still due out to the organization or have been received and the document register entry has not been

completed. Determine if the parts clerk is reviewing the monthly consolidated listings. Incompleted entries indicate poor repair parts administration.

(3) Examine repair parts requests that have been prepared but not yet submitted to the supporting supply activity. A time lapse of more than 3 or 4 hours for a deadlined item or 24 hours for a nondeadlined item between the initiation of the repair part requirement (e.g., a DA Form 2404 prepared by an operator or a mechanic) and the time the parts request is made indicates a mediocre repair parts supply operation.

(4) Check for the "hanger queen," a nonoperational item used as a source of parts exchange to avoid following proper resupply procedures. Prolonged deadline status and parts cannibalization by units indicate failure to follow the prescribed system and/or a lack of confidence in supporting activities.

f. Maintenance and equipment records. There are infinite possibilities for equipment records to reflect the proficiency of organizational maintenance. Only three indicators will be listed here. If a more detailed inspection is considered necessary, use of the three indicators cited should lead to other equipment records that will confirm or alter the initial findings.

(1) Inspect copies of DD Form 314, Preventive Maintenance Schedule and Record. A properly prorated, current maintenance schedule indicates a good PM program. Inked-in dates recording completed services should be current within 10 percent. Proration of scheduled services should distribute the maintenance workload equally over a given period. For future reference, the serial or unit numbers of five or six items due or undergoing a periodic service should be noted. Ascertain if supervisory personnel have forecasted known component replacement items (e.g., fuel filters, oil filters, and seals) and requested required quantities from support activities. Failure to forecast needed requirements indicates poor maintenance management.

(2) Review several completed Equipment Inspection and Maintenance Worksheets,

DA Forms 2404, prepared for recent operational periods or scheduled maintenance services. Information required by blocks in the heading (e.g., mileage, hours of operation, technical publication(s), and date) should be complete. Equipment faults entered should be clearly described by the operator or mechanic. Check the forms for items that have recently undergone a PM service ((1) above). Determine how many operator/crew-type faults were found and corrected by the mechanic. Excessive operator faults detected indicate a need for additional training.

(3) Inspect several DA Forms 2408-4, Weapon Record Data. Ascertain if rounds fired are being maintained by zone. Determine if maintenance actions are being related to rounds fired; for example, the torque key on the M109A1 howitzer must be measured after each 1,500 rounds fired regardless of zone. If personnel cannot determine the total rounds fired or cannot relate maintenance actions to rounds fired, a lack of management is evident.

g. Publications. Publications attain principal importance as a maintenance management indicator because the use of outdated publications, or lack of certain publications, results in improper procedures or trial-and-error maintenance.

(1) First, insure that the shop office has a system for reviewing and requesting required publications. A copy of DA Pamphlet 310-4 with the latest published change must be on hand. Briefly scan the latest change and look for marginal checks or notes by the most recently published, rescinded, or superseded TM, TB, or LO. Such marks indicate that a review has been made to determine if the latest publications are on hand or on requisition.

(2) Observe the location of equipment technical manuals and lubrication orders in the shop. Examine two or three for equipment on hand within the unit; they should show signs of wear and frequent use. A good maintenance shop will have the most commonly required technical publications chained or tied to a board next to the unit's repair benches or shop.

18-9. A Commander's Checklist

a. Do I receive a daily status report as to the operational status of all major equipment in my battery?

b. Are my operators adequately trained, or do they need advanced training? Refresher training?

c. Are my maintenance personnel adequately trained, or do they need additional training?

d. Do I know the status of all PLL requests for inoperative equipment in my unit?

e. Do I know how to "pull an ESC" on my mission-essential equipment? Do my operators?

f. Have I allotted sufficient time on the battery training schedule for required maintenance operations?

g. Does my unit have a *current* maintenance SOP, and are we operating in accordance with the SOP?

h. Is my PLL current (demand supported), and what is its percentage of fill?

i. Are my motor pool and shop areas adequate? Efficiently organized and used? What unsafe conditions exist? Have I initiated corrective action and followup?

j. Are the tools/tool sets authorized my unit by TOE/MTOE on hand? On order? Serviceable?

k. Have I conducted a command inspection on all my unit equipment recently?

l. Does my parts clerk reconcile

outstanding parts requests with my supply source on a routine basis?

m. How long is it taking my personnel to prepare and get a piece of equipment into support shops?

n. Have replenishment requisitions been initiated for repair parts at zero balance?

o. Are repair parts located in accordance with stock record or locator records, and are on-hand balances correct?

p. Do I select one item of equipment each day and spot-check it for correctness or serviceability?

q. Is authorized test equipment on hand? On order? Serviceable? Calibrated?

r. Have I established adequate controls for the safeguard of tools, tool sets, and test equipment?

s. Are my mechanics proficient in the use of the authorized test, measurement, and diagnostic equipment (TMDE), and do they use it?

t. Do I have any problems that MAIT can assist me in solving?

u. Do I have a copy of DA Pamphlet 700-4, *Commander's Maintenance Evaluation Techniques, A Guide for Commanders*, and am I using it?

v. Do I have a copy of DA Pamphlet 750-18, *Commander's Maintenance Guide*, and am I using it?

w. Has my pinpoint account been reviewed in the last 6 months, and is a copy of the review on file?



APPENDICES

- A. SELECTED CHARACTERISTICS OF FIELD ARTILLERY CANNONS**
- B. GLOSSARY**
- C. CANNON SECTION EVALUATION AND TRAINING**
- D. GUNNER'S QUALIFICATION TEST**
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- F. MINIMUM QE RAPID FIRE TABLES**
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APPENDIX B

GLOSSARY

—A—

advance party—A group of unit representatives dispatched to a planned new position in advance of the main body to prepare the position for the arrival of the unit and its equipment.

advanced individual training (AIT)—Training given to enlisted personnel after completion of basic combat training (BCT). AIT teaches the individual specific skills that result in the award of a military occupational specialty (MOS).

advanced noncommissioned officer course (ANCOC)—Course taught at the service school and designed to train selected E6s (skill level 3) to serve in skill level 4 positions. Attendees are selected by Department of the Army on a competitive basis.

aiming circle—An instrument used primarily to measure horizontal and vertical angles and as a laying instrument to place the tube of an indirect fire weapon in a desired direction. The specific uses of the aiming circle are discussed in detail in chapter 8.

aiming point—A sharply defined point or object on which the sight of a weapon is aligned when the weapon is laid for direction. There are two general types of aiming points—*distant* and *close-in*.

army training and evaluation program (ARTEP)—A diagnostic tool used to program training to achieve a specified level of proficiency and to evaluate performance. Each ARTEP provides training and evaluation outlines that contain minimum collective training performance objectives (task, condition, standard) for specific missions and levels of training. Additionally, it contains guidance on how the ARTEP can be used for training evaluations.

azimuth—A horizontal, *clockwise* angle measured from north. This angle may be a —

magnetic azimuth, measured from magnetic north; a

true azimuth, measured from true north; or a

grid azimuth, measured from grid north. This is the azimuth normally employed in the field artillery. Normally, the command given to indicate the grid azimuth of the direction of fire is AZIMUTH (so much).

—B—

back-azimuth—The azimuth plus or minus 3,200 mils.

base piece—The weapon whose shooting strength is closest to the average shooting strength of the battery. It is located on the battery center and normally is used for registration.

basic combat training (BCT)—Training in basic military subjects and the fundamentals of soldiering given to newly enlisted Active Army and Reserve Component personnel without prior military service.

basic issue items (BII)—Crew/operator maintenance accessories and tools that are initially issued with a particular end/component item. Range and quantity of BII are designated in the basic issue items list within the applicable operator's manual.

basic noncommissioned officer course (BNCOC)—Course designed to teach the junior combat arms NCO to be a section chief, progressing from skill level 2 to skill level 3. The student acquires additional technical expertise in his MOS and receives instruction on how to train and lead his section to successful performance of ARTEP missions. Taught at installation/division level.

battery center—The point over which the base piece is located. It is the chart location of the battery and should be near the geographic center of all the weapons.

battery operations center (BOC)—A facility established to serve as an alternate FDC and as the battery CP.

boresighting—The process by which the optical axes of the weapon sights are alined parallel to the axis of the cannon tube. The primary methods of boresighting are with the alinement device, a distant aiming point, or the testing target. Emergency methods are discussed in chapter 12.

—C—

centralized training—Training that is controlled, programed, and scheduled by a headquarters above the unit normally responsible for conducting the training.

close-in aiming point—The primary close-in aiming point is the infinity collimator, a lightweight optical instrument that simulates an aiming point at infinity. The collimator should be emplaced 4 to 15 meters to the left front of the weapon. A secondary close-in aiming point is a set of two aiming posts. If possible, the far aiming post should be placed 100 meters from the weapon. In any case, the near post must be placed half the distance to the far post. When alined, the two posts establish a line along which the panoramic telescope is sighted when laying for direction.

collective training—That training which prepares soldiers to perform those team or unit tasks essential to the accomplishment of a unit's TOE and/or operational mission.

command post exercise (CPX)—A tactical exercise that includes only the command and communications personnel of a unit. For the cannon battery, this includes the FDC, the BOC, and appropriate FIST personnel. The purpose of the CPX is to exercise and train these personnel without committing the entire unit.

commander's manual—A manual that lists for the training manager all the critical tasks, by skill level, that every soldier of a given MOS must master. Designed for all officers/senior NCOs having soldiers of the particular MOS under their command supervision, it also lists study materials and

references applicable to each task as well as the source and location of task training.

common deflection—The deflection corresponding to the initial azimuth of lay that the FDC has plotted on its firing charts. The common deflection for all weapons with M100-series sights is 3200. For the M101A1 it is 2800, and for the M114A1 (A2) it is 2400.

conditions—A statement that specifies the circumstances under which a particular task is to be performed; e.g., information/equipment provided or denied a soldier for the performance of a task.

converged sheaf—A sheaf in which the planes of fire meet at a designated point.

counterfire—Fire delivered for the purpose of destroying or neutralizing indirect fire weapon systems.

—D—

decentralized training—Releases the authority and responsibility for the detailed planning, conduct, and internal evaluation of training to the battalion or separate company level. Brigade headquarters and above retain the responsibility for providing mission-type guidance to their subordinate units, allocating training resources, coordination, and the broad supervision/evaluation of training.

declination constant—The horizontal clockwise angle from grid north to magnetic north; in other words, it is the grid azimuth of magnetic north. Usually, the declination constant is recorded for every instrument equipped with a magnetic needle. The constant for any instrument will vary in different localities, and the constant of different instruments in the same locality also will vary. This variation is due to slight differences in manufacturing and to the shock from handling of the instruments during normal use.

dedicated battery—A cannon battery whose total firepower is immediately available to suppress enemy direct fire weapons that threaten a designated maneuver company/team. For additional information, see FM 6-20 and FM 6-40-5.

deflection (DF)—The horizontal, clockwise angle from the line of fire—or the rearward extension of the line of fire—to the line of sight to a designated aiming point. The vertex of the angle is at the sight. If the pieces are equipped with the M12-series panoramic telescopes, deflection never exceeds 3,200 mils. In addition to deflection as a fire command, the firing battery is concerned with both *common* and *referred* deflection.

direct laying—The aiming of a piece by sighting directly on the target.

direct support maintenance—Maintenance that is authorized and performed by designated maintenance activities in direct support of using organizations. This category of maintenance is limited to repair of end items or unserviceable assemblies in support of using organizations on a return-to-user basis.

distant aiming point (DAP)—A point at least 1500 meters from the pieces so that normal displacement in firing or traverse will not cause a horizontal angular change in direction (with the same setting on the azimuth scales) of more than one-half mil. An advantage of using a distant aiming point is that it may be used immediately upon occupation of a position. Some disadvantages of using a distant aiming point are that it may be obscured by darkness, dust, fog, or smoke; illumination is not practicable; and the pieces are not *exactly* parallel when laid on a common deflection.

distribution of fire—The pattern of bursts in the target area. Normally, all pieces of a battery fire with the same deflection and the same quadrant elevation. It is sometimes necessary to adjust the pattern of bursts to the shape and size of the target. Also, there are times when the battery must occupy terrain positions without regard to the spacing between howitzers. In these cases, individual piece corrections for deflection, fuze setting, and quadrant elevation are computed and applied to obtain a specific pattern of bursts. In some cases, a rapid computation and application of a deflection difference is made to make the distance between flank bursts approximately equal to

the width of the target. See *terrain gun position corrections*.

—E—

end of the orienting line (EOL)—A point on the orienting line (OL) marked by any sharply defined permanent or semi-permanent object such as a steeple, flagpole, or stake. If possible, it should be visible during darkness.

equipment serviceability criteria (ESC)—Tests and measurements prescribed for mission-essential, maintenance-significant equipment to evaluate its capability to satisfactorily perform its primary mission for a period of 90 days with normal maintenance support.

equivalent full charge (EFC)—The method used to determine the remaining life of a cannon tube. To convert to EFC rounds, the quantity of rounds fired is multiplied by the EFC factor as indicated in the weapon TM. Computations are recorded on DA Form 2408-4.

evaluation of training—The processes that by objective and subjective means, are used to determine the extent of the learning progress of individuals and units. The purpose is to determine if a training objective has been attained. Evaluation provides the training manager with the information he needs to modify or update his training program and provides feedback to trainers on the effectiveness of their training.

—F—

field storage location (FSL)—A controlled, limited-access area in which a unit having custody of nuclear weapons stores them. Its primary purpose is to prevent unauthorized and uncontrolled access to the weapons.

fire support team (FIST)—In fire support operations, a team comprising of a team chief (FA lieutenant) and the necessary additional personnel and equipment required to request, coordinate, and direct fire support efforts for company-size units.

financial training resources—Funds allocated to conduct training activities, to purchase training aids/devices, and/or to purchase other materials to be used for training. School TDY funds and adventure training funds are examples.

fire control alinement tests—Tests performed to determine if the fire control equipment on a howitzer or gun is correctly alined. Certain adjustments of misalined equipment can be made by the crew or the artillery mechanic; whereas, other adjustments must be made by higher categories of maintenance. Formerly referred to as basic periodic tests.

—G—

grid declination—The smaller angle between true north and grid north. Grid declination is indicated in the marginal data of maps as east or west of true north.

grid north—The north direction of the vertical grid lines on a military map, a photomap, or a grid sheet. Since determination of firing data for direction is based on grid north, the term "azimuth" normally means grid azimuth.

—H—

hasty survey—Techniques used to establish rapid and sufficiently accurate direction and/or position data through simplified procedures and with cannon battery TOE equipment. See chapter 9 for detailed procedures.

hot platoon—A cannon platoon designated to maintain full crews at their posts for instant reaction to a fire mission. This technique minimizes reaction time to calls for fire and allows the other platoon(s) to accomplish the various tasks that must be performed during position improvement.

human resources—All personnel who participate in training. It includes those who assist the commander in the planning, conduct, and evaluation of training and those individuals who receive the training.

—I—

immediate actions—Actions taken or

duties performed in instantaneous response to enemy attack, particularly by artillery (counterfire).

immediate suppression—Field artillery fires required when the enemy has fired from, or has been seen and can fire from, a given location such that direct fire weapons and supporting field artillery must respond instantaneously.

indirect laying—The aiming of a piece by sighting at an aiming point other than the target. The piece is laid for direction by setting a given deflection on the sight and traversing the tube until the line of sight of the panoramic telescope is on the aiming point. The piece is laid for elevation on the range quadrant or gunner's quadrant by elevating or depressing the tube until the appropriate bubble is centered.

individual training—The training received by an individual without regard to grade or level of proficiency. Individual training begins when the individual enters the Army and continues throughout his service. Initially, emphasis is placed on development of the individual as a basic soldier. Emphasis is then shifted to the development of the primary skills necessary to perform in a specific MOS at varying skill levels.

institutional training—Training, both individual and collective, that is conducted in schools (Army service school, USAR school, unit school) or army training centers (ATC).

—J—

job book—A pocket-size booklet designed to serve as an informal record of the soldier's proficiency in the tasks required of his present duty position. It is issued to the soldier and NCO supervisor. The pencil entries—made on a "GO" or "NO GO" basis for soldier's manual tasks—serve as a valuable section-level training management tool. It is *not* to be inspected.

—L—

line of fire—The direction of the line established by the tube or any line parallel to

that line in the firing battery area.

—M—

magnetic declination—The smaller angle between true north and magnetic north. This angle is indicated in the marginal data of maps as east or west of true north. Since the magnetic declination varies slightly from year to year, a correction factor—the *annual magnetic change*—is also shown in the marginal data of military maps.

magnetic north—The direction to the magnetic North Pole.

minimum quadrant elevation (MIN QE)—The lowest quadrant elevation of a weapon at which the projectile will safely clear an obstacle between the weapon and the target. This applies to crests visible from the battery position and to intermediate crests along the trajectory.

mission-related training—Individual or collective training that contributes directly to the accomplishment of the unit mission. It includes a wide variety of activities and excludes such diversionary activities as special duty, administrative appointments, general educational classes, honor guards, fatigue details, and routine medical care.

—O—

one-station unit training (OSUT)—Training given to initial entry level trainees for high density MOSs that totally integrates BCT and AIT. OSUT trains the individual in basic soldier skills and in skill level 1 tasks that result in the award of the MOS.

on-the-job training (OJT)—A training process whereby students or trainees acquire knowledges and skills through actual performance of duties under competent supervision, in accordance with an approved, planned program.

open sheaf—A sheaf in which the lateral distance between adjacent bursts equals the maximum effective width of burst.

operator/crew maintenance—Includes the proper care, use, and operation of equipment by the operator or crew. It consists

of performing before-, during-, and after-operation maintenance; reporting malfunctions that they are not authorized to correct; and making proper entries on equipment records as required by TM 38-750.

organizational maintenance—Maintenance that is the responsibility of, and performed by, a using organization on its assigned equipment. It includes both battery and battalion levels.

orienting angle (OA)—A horizontal, clockwise angle from the line of fire to the orienting line.

orienting line (OL)—A line of known direction, materialized on the ground near the firing battery, that serves as a basis for laying the battery for direction. The azimuth of the orienting line is the direction from the orienting station to a designated end of the orienting line (EOL).

orienting station (OS)—A point established on the orienting line. The aiming circle is set up over this point to lay the pieces by the orienting angle method.

—P—

panoramic telescope (usually called the sight or pantel)—A fire control instrument used for either direct or indirect fire. When the panoramic telescope is used in its most common role, indirect fire, it allows the operator to apply a specified change in the direction (deflection) to the tube of the piece by changing the line of sight of the telescope the same amount and then traversing back to the fixed point. Panoramic telescopes used on current field artillery weapons are as follows:

Weapon	Series	Max DF	Common
			DF
M101A1	M12	3200	2800
M114A1(A2)	M12	3200	2400
M102	M100	6400	3200
M109/M109A1	M100	6400	3200
M110/M110A1	M100	6400	3200
M107	M100	6400	3200

parallel (normal) sheaf—A sheaf in which the planes of fire of all pieces are parallel.

Regardless of the range, the bursts will be spaced laterally at the same intervals as the pieces.

performance objective—A statement that specifies an individual or team/unit task, the condition(s) under which the task is accomplished, and the training standard required to demonstrate minimum acceptable proficiency.

performance-oriented training and testing—A training and testing technique through which individuals or crews/units perform one or more tasks, under specified conditions, to demonstrate a level of proficiency matching an expressed standard.

preventive maintenance (PM)—Care and servicing to maintain equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of failures either before they occur or before they develop into major defects.

preventive maintenance indicators (PMI)—Areas of possible failure or malfunction in equipment that can be detected by localized application of the sense of sight, sound, touch, or smell to indicate the condition and quality of maintenance.

primary noncommissioned officer course (PNCOC)—A course designed for the combat arms soldier in grade E4 who has been selected by his commander as having NCO potential. Taught at installation/division level, it includes the leadership and training skills needed for advancement to skill level 2.

prime time for training—An established period of time (hours, days, or weeks) devoted entirely to mission-related training. It should be established at the lowest level possible with the maximum number of personnel present for training. Administrative absences should be limited to non-prime time periods, to increase training effectiveness.

priority target—A target designated as critical by a maneuver commander on the basis of type, location, or time sensitivity. A priority target is one that firing units lay on while not engaged in a fire mission.

Generally, one battery will be laid on each priority target (as with an FPF). However, in dedicated battery operations, a platoon normally lays on a planned priority target.

—Q—

"Q" service—A scheduled maintenance service, usually associated with tracked vehicles, that normally is performed every 750 miles of operation.

—R—

refer—To measure (using the panoramic telescope) the deflection to a given aiming point without moving the tube. In some instances, this *referred deflection* will be reported. If it is desired that it be recorded, the command RECORD REFERRED DEFLECTION is announced.

referred deflection—(See *refer*).

—S—

"S" service—A scheduled maintenance service, usually associated with wheeled vehicles, that normally is performed every 6,000 miles of operation or every 6 months, whichever comes first.

scheduled maintenance service—A periodic prescribed inspection and servicing of equipment accomplished on a calendar, mileage, or hours-of-operation basis.

self-study—Individual study by which the soldier learns new skills, acquires new knowledges, or reinforces those already learned.

sheaf—The lateral distribution of the bursts of two or more pieces fired together. The width of the sheaf is the lateral distance (perpendicular to the direction of fire) between the centers of flank bursts. The front covered by any sheaf is the width of the sheaf plus the effective width of one burst. A sheaf may be formed in any of the following patterns: *converged, open, parallel (normal), or special*.

skill level (SL)—The level of proficiency within a given MOS, indicated by the fourth digit of the MOS code. A howitzer section

chief (E6), MOS 13B30, is at skill level 3.

skill qualification test (SQT)—A test designed to determine if the soldier is qualified in his present skill level and if he is eligible for advancement to the next higher skill level. It consists of three components: written exercises, hands-on performance, and commander's certification.

small unit transceiver (SUT)—A short-range FM radio designed to supplement the intrabattery wire system and to enhance command and control of marches and movements. Basis of issue will be one per cannon section, FDC, and BOC.

soldier's manual—An MOS training guide (FM) that contains those critical tasks in which a soldier must be qualified to be proficient in his MOS and to advance to the next higher MOS skill level. Each soldier is responsible for retaining and maintaining his own manual.

special sheaf—Any sheaf other than those previously defined.

suppressive fires—Fires, direct and indirect, brought to bear on known or likely enemy locations to degrade the enemy's ability to place effective fire on friendly maneuver elements.

—T—

tactical exercise without troops (TEWT)—A training exercise in which a unit's leaders plan and discuss the movement and disposition of simulated troops or equipment at a given location. Its focus is the discussion and learning of tactical principles in a tactical setting.

task—A statement that specifies an action to be performed by an individual or team/unit.

terrain gun position corrections (TGPC)—Precomputed corrections carried at the firing battery to compensate for terrain positioning and muzzle velocity differences.

terrain march—An off-road movement used to reduce vulnerability and to avoid traffic congestion, particularly when enemy observation, interdiction by artillery, or air

attack is likely. A unit or an element of a unit using this technique travels along gullies and close to treelines and hill masses.

trainers—Personnel whose duties include the requirement to prepare, conduct, and evaluate training (e.g., a howitzer section chief who prepares, conducts, and evaluates howitzer crew training).

training calendar—A visual aid depicting a schedule of principal training activities for a given period of time. It is used as a management tool to facilitate the planning and programming of major training activities (e.g., FTXs and range firing).

training extension course (TEC)—A multimedia approach to individual and small group training. TEC lessons can be audiovisual, audio only, or programed text.

training goal—A broad statement of desired individual or unit proficiency with respect to a capability required for mission/readiness accomplishment.

training management—The art of employing resources (human, physical, financial, and time) in a manner that permits efficient and effective development of individuals and units to successfully accomplish peacetime and combat missions.

training managers—Individuals who are responsible for the planning, organization, conduct, and evaluation of training. Training managers include the commanders who develop a training program or who provide guidance to other commanders.

training program—A program that outlines the general plan for the conduct of training for the entire organization for specified periods of time. They are prepared and disseminated for the information of all personnel concerned with training.

training resources—Those resources (human, physical, financial, and time) used to conduct or support training. They may be internally controlled by a unit or externally controlled by other headquarters, who allocate their use to units as required.

training standard—A statement that specifies the minimum acceptable

proficiency required of an individual or team/unit in the performance of a particular task under stated conditions.

true north—The direction to the geographic North Pole.

—U—

unit training—Training, either individual or collective, conducted in a unit.

36. You are inspecting the M72A2 LAW and you see the sight has a deep scratch in the front lens. What should you do?

- a. Don't worry about it.
- b. Turn the M72A2 LAW in to your ammunition section.
- c. Remove the scratch with rubbing compound.

Questions 37 through 39 require you to answer questions on the actions you would take if your M203 grenade launcher fails to fire.

37. How long should you wait before opening the breech?

- a. 3 seconds.
- b. 1 minute.
- c. 2 minutes.

38. What precaution should you take when unloading the M203?

- a. Let the round fall to the ground.
- b. Catch the ejected round.

39. The primer has been dented. What should you do with the round?

- a. Set it aside and keep it separated from the good rounds.
- b. Put it back in the M203 and fire it again.

40. Your M16A1 rifle fails to fire. What is the first thing you should do to clear the stoppage and fire the weapon?

- a. Pull the bolt to the rear.
- b. Tap up sharply on the base of the magazine.
- c. Put the weapon on SAFE.

Questions 41 through 43 pertain to the following situation:

Situation: You are a cannoneer on a cannon that fires separate-loading ammunition. The cannon has just been fired and you are to clear the powder chamber.

41. What do you do *first*?

- a. Swab the chamber with water.
- b. Announce BORE CLEAR.
- c. Announce SHOT.

42. To whom do you announce BORE CLEAR?

- a. The XO.
- b. The chief of section.
- c. The fire direction center.

43. If you are firing more than one round, what should you announce after each round is fired?

- a. BORE CLEAR and charge.
- b. BORE CLEAR and number of rounds fired.
- c. BORE CLEAR, number of rounds fired, and quadrant.

44. The four lifesaving measures are:

- a. Clear the airway and restore breathing and heartbeat as necessary.
- b. Treat for shock control.
- c. Apply dressing and bandage.
- d. Stop the bleeding.

The proper sequence for these measures is—

- a. A, B, C, D
- b. A, D, C, B
- c. A, D, B, C
- d. B, A, C, D

45. If any member of the battery observes a dangerous situation, he can stop a fire mission already in progress by giving the command—

- a. STOP FIRING.
- b. CANCEL FIRING.
- c. CEASE FIRE.
- d. CHECK FIRING.

46. For best results, the collimator should be emplaced _____ to _____ meters from the howitzer.

- a. 3 to 13
- b. 4 to 15
- c. 0 to 15
- d. 3 to 10

47. Regardless of the distance at which the far aiming post is set, the near aiming post must be emplaced—

- a. about 50 meters from the howitzer.
- b. exactly half the distance to the far aiming post.
- c. as the situation permits.
- d. 100 meters from the howitzer.

48. In a fire command, the number 3167 is pronounced—

- a. thir-tee wun six-tee seven.
- b. thuh-ree thouzand wun six seven.
- c. thuh-ree wun six seven.
- d. three thouzand wun hundred six-tee seven.

49. Number 2 desires the FDC to repeat the deflection. Number 2 should say—

- a. REPEAT DEFLECTION, NUMBER 2.
- b. NUMBER 2, DEFLECTION?
- c. DEFLECTION, NUMBER 2?
- d. SAY AGAIN DEFLECTION, NUMBER 2.

50. When separate-loading ammunition is being fired, the fire command for lot includes two letters, XY. The ammunition component(s) represented by the letter "X" in lot XY is (are)—

- a. propellant.
- b. projectile.
- c. propellant and projectile.
- d. propellant, projectile, and fuze.

51. The primary reason for painting projectiles is to—

- a. prevent rust and corrosion.
- b. provide an easy method of identification.
- c. facilitate handling and storage.
- d. enhance the camouflage of the position.

83. The recoiling parts of the M101A1 are held in the in-battery position by the force of the—
- oil pressure compressing the nitrogen in the recuperator cylinder.
 - compressed oil in the recoil cylinder.
 - compressed oil in the counterrecoil cylinder.
 - compressed spring in the equilibrator.

Questions on the 155-mm Howitzer M109/M109A1

84. The equilibrator system of the M109/M109A1 must be adjusted by increasing or decreasing the—
- length of the temperature-adjusting screws.
 - tension in the equilibrator springs.
 - power to the electric-motor-driven hydraulic system pump.
 - pressure in the equilibrator system.
85. If the M109/M109A1 is not fired, the chamber evacuator valves should be removed and cleaned—
- daily.
 - weekly.
 - monthly.
 - semiannually.
86. To engage the high-speed manual traverse on the M109/M109A1, the operator moves the MANUAL POWER selector to the—
- right and the speed selector lever to the right.
 - right and the speed selector lever to the left.
 - left and the speed selector lever to the right.
 - left and the speed selector lever to the left.
87. The number of rounds that can be carried in the ammunition racks in the M109/M109A1 is—
- 28.
 - 36.
 - 42.
 - 50.
88. The maximum rate of fire for the M109/M109A1 is—
- 1 round per minute for 3 minutes.
 - 2 rounds per minute for 4 minutes.
 - 3 rounds per minute for 4 minutes.
 - 4 rounds per minute for 3 minutes.
89. The zero pressure check on the M109/M109A1—
- normally is performed by an artillery mechanic.
 - indicates the amount of precharged nitrogen in the main accumulator.
 - indicates if there is sufficient hydraulic oil in the main powerpack reservoir.
 - All of the above.

Questions on the 155-mm Howitzer M114A1(A2)

90. One complete turn of the traversing handwheel of the M114A1(A2) will move the tube—
 - a. 10.3 mils.
 - b. 12.6 mils.
 - c. 14.8 mils.
 - d. 16.1 mils.
91. The proper amount of recoil oil reserve in the replenisher of the M114A1(A2) will be indicated when the replenisher piston rod measures—
 - a. 3½ inches.
 - b. 5½ inches.
 - c. 7½ inches.
 - d. 9½ inches.
92. The proper volume of oil in the recoil mechanism system of the M114A1(A2) is maintained at all times by action of the—
 - a. floating piston.
 - b. recuperator.
 - c. replenisher.
 - d. variable recoil and cam assembly.
93. The M114A1(A2) can be traversed _____ mils to the left from the center of traverse.
 - a. 418
 - b. 428
 - c. 438
 - d. 48
94. The replenisher oil reserve on the M114A1(A2) should be checked prior to firing and also—
 - a. after firing.
 - b. after every 10 rounds fired.
 - c. after every 100 rounds fired.
 - d. upon completion of the first fire mission.

Questions on the 8-Inch Self-Propelled Howitzer M110/M110A1

95. In boresighting the M110/M110A1 with the elbow telescope M116, corrections in azimuth and elevation are made by—
 - a. changing the reticle in the telescope.
 - b. adjusting the elbow telescope mount M138.
 - c. adjusting the elevation quadrant M15.
 - d. moving the fine index on the telescope head.
96. The loader-rammer assembly of the M110/M110A1 is operated by—
 - a. manual power only.
 - b. manual or electric power.

- c. electrical and hydraulic power.
 - d. manual or hydraulic power.
97. The manual traverse control on the M110/M110A1 is intended to be used only—
- a. during two-man, two-sight direct firing.
 - b. as a backup in case of power failure.
 - c. when the howitzer is within 2.0 mils of the desired deflection.
98. The two recoil spade cylinders that raise or lower the recoil spade on the M110/M110A1 are controlled by a lever located at the—
- a. left rear of the vehicle.
 - b. right rear of the vehicle.
 - c. gunner's seat position.
 - d. assistant gunner's seat position.
99. To overcome friction buildup on the recuperator floating piston that has caused the recuperator oil index of the M110/M110A1 to stick, it is necessary to—
- a. place the power takeoff switch on the ON position.
 - b. position and hold the oil pump switch in the OVERRIDE position, and place the retracting control valve handle in the RETURN position.
 - c. notify support maintenance personnel.
100. The control for the fixed fire extinguisher system of the M110/M110A1 is located in the—
- a. engine compartment.
 - b. operator's compartment.
 - c. battery compartment.
 - d. turret well.
101. To reestablish the recuperator oil reserve of the M110/M110A1, it is necessary to place the oil pump motor switch in the ON position and to place the retracting control handle in the—
- a. RETRACT position.
 - b. NORMAL position.
 - c. HOLD position.
 - d. RETURN position.
102. When you build up the pressure on the main accumulator with the PTO pump, the engine should be idled between _____ rpm.
- a. 1,200 and 2,000
 - b. 1,000 and 1,500
 - c. 600 and 1,200
103. Normally, the main oil pump is used to—
- a. emplace the spade.
 - b. move the tube in or out of battery.
 - c. replenish the system.
 - d. maintain pressure.

Questions on the 175-mm Gun M107

104. Normally, the tube of the M107 will begin minimum recoil at _____ of elevation.
- 178 mils
 - 480 mils
 - 950 mils
 - 1,100 mils
105. The engine-driven hydraulic pump, used to initially charge the accumulator of the hydraulic system of the M107, should not be operated—
- in excess of 1,200 rpm.
 - for raising or lowering the spade.
 - to save the vehicle batteries.
106. The M107 is classified as a—
- light field artillery weapon.
 - medium field artillery weapon.
 - heavy field artillery weapon.
 - very heavy field artillery weapon.
107. The recuperator cylinder of the M107 is charged when the retracting control valve handle is placed in the—
- RETRACT position.
 - NORMAL and HOLD positions.
 - OFF position.
 - RETURN position.
108. When electrical power from one M107 is used to start another M107, damage to the voltage regulator and rectifier of the vehicle being started can be prevented by—
- reversing the polarity of the battery cables.
 - turning the master switch of the receiving vehicle to OFF.
 - using high-capacity jumper cables.
 - routing the incoming current around the batteries of the receiving vehicle.
109. The limits of elevation of the M107 are governed by—
- the solenoid valve circuit.
 - the elevating hydraulic control.
 - the elevating motor brake.
 - stops on the cradle.
110. The oil reserve for the recoil cylinder of the M107 recoil mechanism is contained in the—
- replenisher cylinder.
 - recuperator cylinder.
 - counterrecoil cylinder.
 - recoil cylinder.

Scoring

For each **go** rating, 8 points will be awarded, for a maximum of 72 points.

For each **no go** rating, 0 points will be awarded.

TASK 3: Disassembly of breech mechanism.

Conditions

After giving the howitzer section approximately 30 minutes to complete task 2 above, the evaluator should read the following situation to the chief of section:

DURING THE CONDUCT OF THE BEFORE-OPERATION CHECKS AND SERVICES ON YOUR CANNON, YOU NOTED A MALFUNCTION IN THE BREECH MECHANISM. IN ORDER TO TROUBLESHOOT THE EXACT CAUSE, YOU DECIDE THAT YOU MUST DISASSEMBLE THE BREECH MECHANISM. YOU MAY SELECT ANY MEMBER(S) OF YOUR SECTION TO PERFORM THIS TASK. HOWEVER, YOU MAY NOT PHYSICALLY PERFORM ANY ACTION. YOU NOW HAVE 1 MINUTE TO SELECT THE SECTION MEMBER(S) TO PERFORM THIS TASK AND ASSEMBLE ALL REQUIRED TOOLS AND MANUALS.

At the end of 1 minute, the evaluator should give the following instructions to the section member(s) performing the task:

YOU ARE TO DISASSEMBLE THE BREECH MECHANISM, TO INCLUDE REMOVAL OF BREECHBLOCK, DISASSEMBLY OF FIRING MECHANISM, AND DISASSEMBLY OF OBTURATOR GROUP (AS APPLICABLE). EVEN THOUGH THIS IS A TIMED EXERCISE, PERFORM ALL ACTIONS IN THE PRESCRIBED SAFE MANNER. ARE YOU READY?...GO!

Evaluation Checklist

Were the breechblock, obturator group, and firing mechanism (as applicable) disassembled in accordance with the appropriate operator's manual?

GO	NO GO

Scoring

If a **go** rating is awarded, the disassembly will be graded according to speed of execution (see table C-1 below).

If a **no go** rating is awarded, 0 points will be awarded for this task.

Table C-1. Scoring—Breech Mechanism Disassembly

M110/M110A1/M107 M109/M109A1	M101A1	M102	M114A1(A2)	Points
0 - 3:30	0 - 1:00	0 - 3:00	0 - 3:45	49
3:31 - 4:00	1:01 - 1:15	3:01 - 3:25	3:46 - 4:05	36
4:01 - 4:20	1:16 - 1:25	3:26 - 3:40	4:06 - 4:20	24
4:21 - 4:30	1:26 - 1:30	3:41 - 3:45	4:21 - 4:30	12
Longer than 4:30	Longer than 1:30	Longer than 3:45	Longer than 4:30	0

TASK 4: Assembly of breech mechanism.**Conditions**

After evaluating task 3, the evaluator should read the following to the chief of section and the section member(s) previously selected for disassembly of the breech:

ASSUME THAT YOU HAVE DISCOVERED THE MALFUNCTION IN THE BREECH MECHANISM. AT THIS TIME, YOU WILL BE EVALUATED ON YOUR ABILITY TO REASSEMBLE THE BREECH MECHANISM IN ITS ORIGINAL CONFIGURATION. ARE YOU READY?....GO!

Evaluation Checklist

Was the breech mechanism properly assembled in accordance with the appropriate operator's manual?

GO	NO GO

Scoring

If a **go** rating is awarded, the assembly will be graded according to speed of execution (see table C-2 below).

If a **no go** rating is awarded, 0 points will be awarded for this task.

Table C-2. Scoring—Breech Mechanism Assembly

M110/M110A1/M107 M109/M109A1	M101A1	M102	M114A1(A2)	Points
0 - 4:00	0 - 1:45	0 - 3:30	0 - 4:15	49
4:01 - 4:30	1:46 - 2:00	3:31 - 4:00	4:16 - 4:35	36
4:31 - 4:50	2:01 - 2:10	4:01 - 4:20	4:36 - 4:50	24
4:51 - 5:00	2:11 - 2:15	4:21 - 4:30	4:51 - 5:00	12
Longer than 5:00	Longer than 2:15	Longer than 4:30	Longer than 5:00	0

TASK 5: Performance of the micrometer test on the gunner's quadrant.**Conditions**

After evaluating task 4, the evaluator should read the following to the howitzer chief of section:

BECAUSE OF RECENT FIRING INACCURACIES, THE XO HAS TOLD EACH HOWITZER SECTION TO IMMEDIATELY PERFORM THE MICROMETER AND END-FOR-END TESTS ON THEIR GUNNER'S QUADRANTS. YOU (OR ANY OF YOUR SECTION MEMBERS) ARE TO PERFORM THE MICROMETER TEST AND ANNOUNCE ANY ERROR AND CORRECTIVE ACTION TO TAKE. AT THE CONCLUSION OF THE MICROMETER TEST, DO NOT REMOVE THE GUNNER'S QUADRANT FROM THE BREECH UNTIL TOLD TO DO SO BY THE EVALUATOR. ARE YOU READY?....GO!

Note. The tube will be returned to loading elevation after each round is fired (if applicable). The M107 gun will fire rounds 4 and 5 at low angle and will be graded at the low angle time standards.

The time for each test will begin when the section chief states the first word of the command and will end when the appropriate cannoneer has fired the weapon.

The cannoneers will perform all of the actions required to fire the weapon, to include using dummy ammunition, if available. Firing will be on the command of the section chief.

Evaluation Checklist and Scoring

4 missions x 30 points per mission = 120 points possible.

Were all bubbles exactly centered when round was fired?

-5 for any uncentered bubble (max cut -5)

Was panoramic telescope correctly alined on aiming point when round was fired?

-5 if not alined (max cut -5)

Were the correct data fired?

-5 for any incorrect data (max cut -5)

Were correct and complete commands issued by all section members (SET, READY, CLOSE, etc.)?

-1 for each incorrect or omitted command (max cut -5)

Maximum Possible Points	Round No.	M109/ M109A1	M110/ M110A1/ M107	M114A1(A2)	M101A1	M102	Penalty Points
6	1	18 sec	18 sec	18 sec	18 sec	18 sec	1 point for each second over
12	2 and 3	13 sec	13 sec	13 sec	13 sec	13 sec	
12	4 and 5	20 sec	20 sec	35 sec	25 sec	25 sec	

TASK 14: Prepare nonnuclear ammunition for firing.

Conditions

Dummy ammunition will be available.

The section chief will be given four 3 x 5 cards that will require the section to prepare selected nonnuclear ammo for firing.

Standard data: Tested section is adjusting piece, shell HE, lot X(Y), FZ Q.

CARD 1

Section chief commands:

FIRE MISSION, BATTERY ADJUST, DO NOT LOAD, CHARGE 5, DEFLECTION 3211, QUADRANT 531.

CARD 2

Use a different charge and fuze delay.

Evaluation Checklist, Cards 1 and 2

Was ammunition sufficiently protected as dictated by the tactical situation?

Was ammo prepared in accordance with fire commands?

Were PD-fuzed projectile and propellant prepared in 30 seconds or less, as announced?

Were delay-fuzed projectile and propellant prepared in 30 seconds or less, as announced?

Was propellant cut to announced charge?

GO	NO GO

CARDS 3 and 4

Use different charge, fuze VT, and fuze TI with appropriate settings.

Evaluation Checklist, Cards 3 and 4

Was ammo sufficiently protected as dictated by the tactical situation?

Was ammo prepared in accordance with fire commands?

Were VT-fuzed projectile and propellant prepared in 40 seconds or less, and was time set to an accuracy of 0 seconds?

Were MTSQ-fuzed projectile and propellant prepared in 40 seconds or less, and was time set to an accuracy of 0.1?

Was propellant cut to announced charge?

GO	NO GO

Scoring

For each **go** rating, 5 points will be awarded; maximum 100 points.

For each **no go** rating, 0 points will be awarded.

TASK 15: Planned priority targets.

Conditions

FDC has announced the firing data for planned targets.

FDC has designated a priority target from the planned target list.

FDC will announce the section and target number to be fired.

Evaluation Checklist

Has the section prepared a section data card for planned targets, to include target numbers, shell, lot, fuze, time, deflection, and quadrant?

Was the howitzer laid on the priority target within 30 seconds of the command from FDC?

Was the charge cut?

Was a fuze with appropriate setting mated to the announced projectile?

Was the projectile in the loading tray (if applicable)?

GO	NO GO

Was the weapon laid for direction and elevation (loading elevation, if necessary)?

Was the weapon fired within 10 seconds of the command from FDC?

GO	NO GO

Scoring

For each **go** rating, 6 points will be awarded, for a maximum of 42 points.

For each **no go** rating, 0 points will be awarded.

TASK 16: Conduct of direct fire.

Note. Once the artillery direct fire trainer (ADFT) is available, you should administer the evaluation contained as an appendix to TM 9-6920-357-10-2 instead of the following evaluations.

Conditions

A stationary target will be emplaced 400 to 800 meters from the howitzer to simulate a moving target.

The section chief will be given a series of 3x5 cards that will require the section to use direct laying procedures.

The two-man, two-sight system will be used by all sections, except that the M114A1 will use the two-man, one-sight system.

The following sample situation cards may be used for all weapons. The examiner should prepare situation cards that are varied and that avoid routine or similar ranges.

CARD 1

A Soviet T62 tank is approaching your battery position and is moving straight toward your howitzer at an estimated range of 600 meters.

CARD 2

The first round fired by your section went over the tank. The tank has now turned and is moving from left to right in front of your position at a speed of 25 mph and at the initial range of 600 meters.

CARD 3

The second round fired by your section was short of the tank and on line. The tank has turned again and is now moving from right to left at a 45° angle going away from your position at a speed of 20 mph.

CARD 4

The tank was hit by your third round but was only partially disabled. You now desire to completely disable the tank and decide to fire on it using the ricochet technique.

Evaluation Checklist/Standards/Scoring

Each situation card will be worth a total of 22 points.

Each section should be evaluated on four separate situation cards, for a total of 88 possible points.

Each situation will be evaluated and penalties assessed as shown below.

STANDARD	PENALTY	MAXIMUM POSSIBLE POINTS CUT
The section chief issues correct and complete fire commands within 20 seconds of the receipt of each card, and section members announce correct commands.	-1 for each incorrect or omitted fire command or for each command that takes over 20 seconds to issue.	-6
The announced lead and range or elevation are set off.	-6 for any incorrect lead or range/elevation.	-6
All bubbles are centered when the howitzer is fired.	-2 for each bubble not level.	-4
The time from the last digit of range/elevation until the howitzer is fired is 10 seconds or less.	-1 for each second over 10.	-6

Section VII. EVALUATION PHASE V

During this phase, conducted as soon after phases II through IV as possible, the following actions are accomplished:

All section personnel will be thoroughly briefed on the detailed results of the evaluation.

Outstanding performances should be recognized and highlighted.

Weak areas should be critiqued in a constructive manner aimed at establishing specific tasks requiring further training emphasis.

All questions will be answered.

Section feedback should be encouraged in an effort to improve the content, organization, or administration of the evaluation.

TASK 8B: Boresight the cannon with the M140 alinement device (061-13B-1026).

Conditions

The examinee will be given a serviceable M140 alinement device installed on the weapon with the tube leveled.

Evaluation Checklist

- a. The examinee levels the cross-level and longitudinal-level vials.
- b. Alines the pantel crosshairs with the crosshairs of the alinement device, using the azimuth and elevation knobs.
- c. Checks the reading on the azimuth counter to insure it is within one-half mil of the proper reading. If it is not, removes the boresight adjustment shaft cover.
- d. Adjusts the azimuth counter reading by depressing the boresight adjustment shaft with a screwdriver and rotating the shaft until the proper reading is indicated on the azimuth counter.
- e. Checks that the sight picture has not changed after the adjustment.
- f. Follows correct procedures in boresighting the cannon so that the line of sight of the pantel is alined with the crosshairs of the M140 within one-half mil.
- g. The azimuth counter indicates the proper reading.

GO	NO GO

Scoring

TIME IN MINUTES

- One or less
More than one

POINTS

- 5
0

TASK 8C: Boresighting the cannon using the standard angle method (061-13B-1033).

Conditions

Examinee will be given a cannon with trunnions level within 90 mils, the standard angle deflection and elevation, scribed lines predetermined during fire control alinement tests, a bright pin attached to the left muzzle witness mark, a pantel with parallax shield, and screwdrivers needed for boresighting.

Evaluation Checklist

- a. The examinee verifies that the recoiling parts are in correct position by checking the scribed line on the cradle (M101A1, M110/M110A1, and M107) or by measuring the distance from muzzle to wiper (M114A1/M114A2).
- b. Installs the parallax shield.
- c. Alines red scribed lines on the panoramic telescope mount.
- d. M114A1(A2):
 - (1) Sets the standard angle elevation with the gunner's quadrant.
 - (2) Sets the standard angle deflection on the azimuth scale.

GO	NO GO

(3) Turns the tangent screws to aline on the pin if not properly alined.

(4) Turns the elevation knob on the pantel to aline the horizontal line on the pin. Adjusts the zero of the elevation scale by loosening the three small screws, then retightens screws.

(5) Verifies that correct deflection and elevation are on the scales and that the sight picture is correct.

e. M101A1, M110/M110A1, and M107:

(1) Elevates tube to correct standard angle elevation, using the gunner's quadrant.

(2) Sets the standard angle deflection on the azimuth scale.

(3) Alines the vertical hairline on the pin by turning the tangent screws (M101A1) or the azimuth knob (M110/M110A1 and M107).

(4) Uses the boresight adjustment shaft to reset the azimuth counter to the correct standard angle deflection (M110/M110A1 and M107) only.

(5) Alines the horizontal hairline on the pin by turning the elevation knob on the pantel. Adjusts the zero of the elevation scale by loosening the three small screws, then retightens screws.

(6) Verifies that the deflection on the panoramict telescope is correct, the sight picture is correct, and tube is on the standard angle elevation.

f. The examinee follows correct procedures in performing the task.

g. The weapon is boresighted to an accuracy of 0 mils.

GO	NO GO

Scoring

TIME IN MINUTES

POINTS

3 or less
More than 3

5
0

TASK 8D: Boresight the cannon using a distant aiming point (061-13B-1029).

Conditions

The examinee will be given a well-defined aiming point at least 1,500 meters distant, a weapon mounted with boresight strings and disk, trunnions level within 90 mils, an assistant to aline the tube on the DAP (M101A1 and M114A1/M114A2), and the tube at zero elevation (M101A1 and M114A1/M114A2) or the tube alined on the DAP (M102, M109/M109A1, M110/M110A1, and M107).

Evaluation Checklist

a. In boresighting the M101A1, the examinee—

(1) With the tube at zero elevation, insures that bubbles are centered and all scales are set on zero.

(2) Has the assistant aline the tube on the DAP. Sets the azimuth and micrometer scales of the pantel to zero.

GO	NO GO

(4) Checks the azimuth counter on the panel. If it does not read 3200, depresses the boresight adjustment shaft with a small screwdriver and turns it until 3200 appears in the window.

- (5) Aligns the horizontal hairline on the DAP with the elevation knob. Slips the elevation scale to zero by loosening the three small screws.
- (6) Rechecks sight picture.
- e. The examinee follows correct procedures in boresighting the weapon.
- f. The weapon is boresighted so that the line of sight of the pantel is alined within one-half mil of the axis of the tube.

GO	NO GO

Scoring

TIME IN MINUTES	POINTS
3 or less	5
More than 3	0

TASK 9: Indirect laying, deflection only (061-13B-1039).

Conditions

- A weapon will be prepared for action, and aiming posts or a collimator will be set out.
- The commands will not necessitate movement of the motor carriage or a shifting of trails.
- A suitable alternate aiming point will be identified to the examinee.
- Actions taken as a result of each command will be graded separately.
- The piece will be laid with the correct settings at the conclusion of each test before the examinee proceeds to the next test.
- The examiner will designate the section number of the piece to be used and will announce, when applicable, special corrections in deflection to be applied by the examinee.
- The examinee will be posted as the gunner.

Evaluation Checklist 9A

Command Number 1: SPECIAL CORRECTIONS, DEFLECTION 3290, NUMBER ONE, LEFT 7. (For M101A1, use DEFLECTION 2890; for M114A1(A2) use DEFLECTION 2490.)

- a. The examinee applies special corrections to the pantel to an accuracy of 0 mils and sets off the deflection.
- b. Centers the cross-level and pitch-level bubbles on the panoramic telescope mount.
- c. Traverses the tube until the vertical line on the panoramic telescope reticle is on the left edge of the aiming post or until the proper collimator sight picture appears.
- d. The examinee then—
 - (1) Checks centering of the bubbles.
 - (2) Re-lays the weapon if necessary.
 - (3) Announces READY when the action is completed.
- e. Examinee follows correct procedures in laying the cannon for deflection.

GO	NO GO

f. Piece is properly laid on prescribed deflection to include any special corrections.

GO	NO GO

Scoring 9A

Timing starts when fire mission deflection is announced and ends with examinee's announcement of READY.

TIME IN SECONDS

POINTS

13.0 or less

4

13.1 to 14.0

3

14.1 to 15.0

2

15.1 or more

0

Evaluation Checklist 9B

GO	NO GO
Command number 2: DEFLECTION 3050. (For M101A1, use DEFLECTION 2650; for M114A1(A2), DEFLECTION 2250.)	

a. The examinee sets the deflection.

b. Leaves the corrections on the gunner's aid.

c. Lays on the aiming posts or collimator.

d. Checks the centering of the bubbles.

e. Announces READY when the action is completed.

f. Examinee follows correct procedures in laying the weapon for prescribed deflection.

g. Piece is properly laid on prescribed deflection.

Scoring 9B

Time begins with fire command and ends with the announcement of READY.

TIME IN SECONDS

POINTS

8.0 or less

4

8.1 to 9.0

3

9.1 to 10.0

2

10.1 or more

0

Evaluation Checklist 9C

Command Number 3: NUMBER ONE, RIGHT 4.

GO	NO GO

a. The examinee applies right 4 to the previous correction on the gunner's aid.

b. Lays on the aiming posts or collimator.

c. Checks the centering of the bubbles.

d. Re-lays the weapon if necessary.

e. Announces READY when the action is completed.

f. Examinee has properly laid the piece for prescribed correction.

Scoring 9C

Time begins with announcement of correction and ends when examinee announces READY.

TIME IN SECONDS**POINTS**

8.0 or less	4
8.1 to 9.0	3
9.1 to 10.0	2
10.1 or more	0

UNGRADED: Examiner commands END OF MISSION. The examinee sets the gunner's aid to 0.

Evaluation Checklist 9D

	GO	NO GO
Command Number 4: AIMING POINT, CHURCH STEEPLE (or some other distant aiming point), REFER. (061-13B-1040)		
a. The examinee turns the panoramic telescope to the church steeple and aligns the reticle pattern on a straight vertical portion of the steeple.		
b. M100-series sight: The examinee uncovers the azimuth counter, reads the deflection, and announces NUMBER ONE, DEFLECTION_____.		
c. M12-series-sight: The examinee reads the deflection on the nonslipping azimuth scale and azimuth micrometer scale and announces NUMBER ONE, DEFLECTION_____.		
d. Examinee properly performs the procedure for completing the command.		

Scoring 9D

Timing begins with command and ends when examinee announces deflection.

TIME IN SECONDS**POINTS**

8.0 or less	4
8.1 to 9.0	3
9.1 to 10.0	2
10.1 or more	0

Evaluation Checklist 9E

	GO	NO GO
Command Number 5: DEFLECTION 3200, REFER. (For M101A1, use DEFLECTION 2800; for M114A1(A2), use DEFLECTION 2400.)		
a. M100-series sight: The examinee pushes in and rotates the reset counter knob until the reset counter reads 3200.		
b. M12-series sight: The examinee loosens the azimuth slipping scale, rotates it to 2800 for the M101A1 or 2400 for the M114A1(A2), slips the azimuth micrometer scale to zero, then tightens the slipping scale. The door to the nonslipping azimuth scale is closed.		
c. The examinee calls NUMBER ONE, DEFLECTION 3200 (for M101A1, 2800; for M114A1, 2400) and steps clear.		
d. Examinee properly performs the procedures for the given command.		

APPENDIX E

TESTS FOR THE QUALIFICATION OF SAFETY PERSONNEL

E-1. Purpose and Scope

This appendix is a series of tests designed to be used by the commander as a guide in developing a program that fully qualifies all personnel involved in firing. The commander may use these tests modified as required to meet local requirements, to determine the level and knowledge of selected personnel concerning safety regulations and procedures, and to determine specific areas that require refresher or remedial training.

E-2. Format

Test I is designed for those personnel not ordinarily tasked to compute safety data (e.g., the howitzer section chief and the chief of firing battery and the gunnery sergeant). Test II is designed for all officers and any other personnel who may be responsible for the computation of safety data. At the discretion of the examiner, Test I may also be given with Test II.

E-3. Test Administration

a. Examinees should be allowed approximately 1 week to prepare for the examination. During this period, they should have access to the following references:

- (1) AR 385-63.
- (2) FM 6-50.
- (3) Local range regulations, SOP's, etc. pertaining to safety.
- (4) Weapon technical and field manuals.

b. The following should be provided by the examiner for use by the examinee for part 4, test II, ONLY:

- (1) Applicable tabular and graphical firing tables.
- (2) Graphical site table.
- (3) FM 6-50.
- (4) AR 385-63.
- (5) One copy of local range regulations.

E-4. Grading

This grading procedure is a recommended method of weighting this examination. Test I is valued at 55 raw points. Tests I and II together are valued at 200 raw points.

TEST I

Part	Cuts per problem	Total weight
1. True and false	1 point each	15
2. Multiple choice	2 points each	20
3. Completion	2 points each	20

TEST II

Part	Cuts per problem	Total weight
1. True and false	1 point each	10
2. Multiple choice	2 points each	10
3. Completion	2 points each	20
4. Performance:		
	26	15
	27	25
	28	25
	29	20
	30	10
	31	10

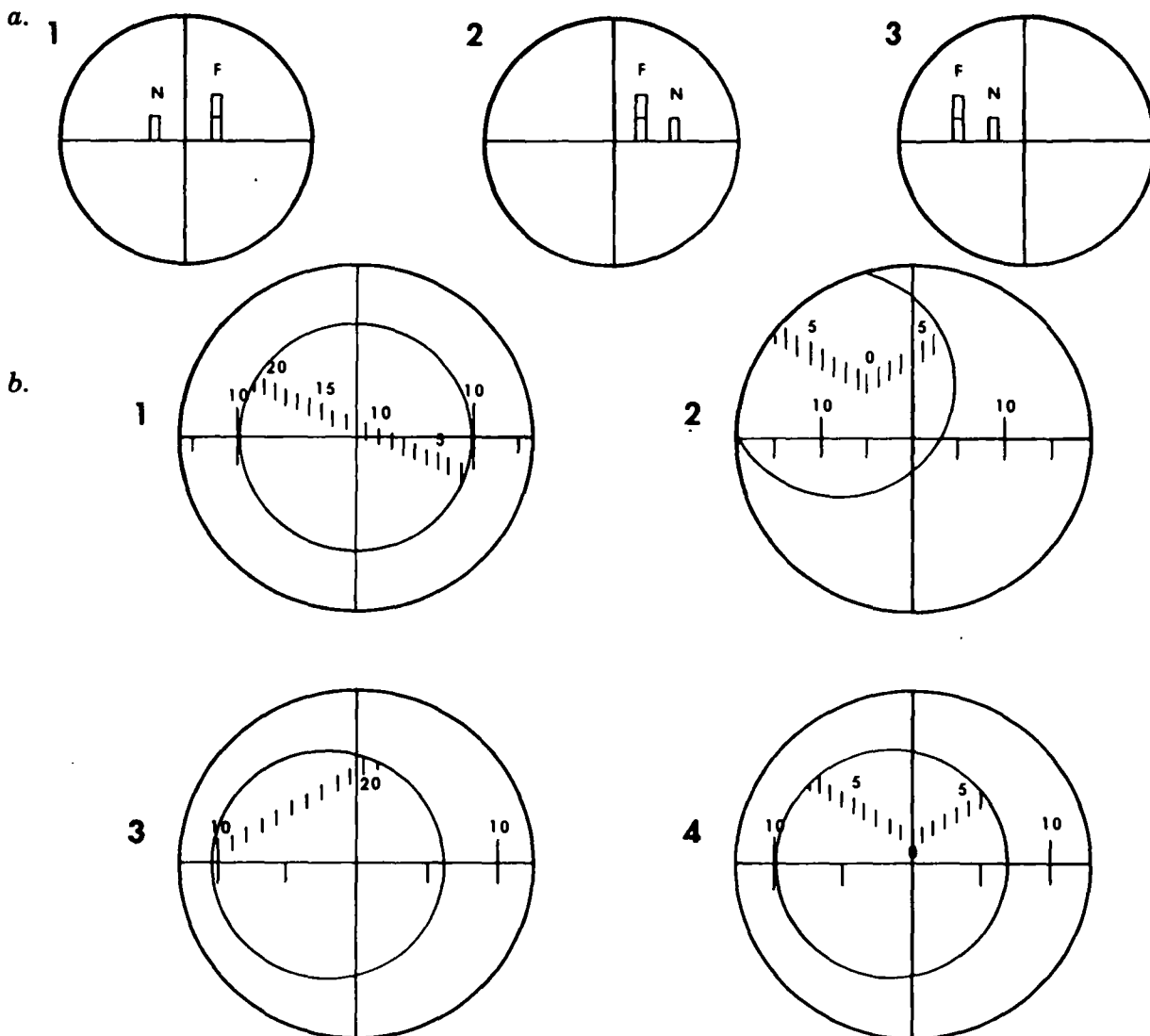
Note. Mathematical errors and expression errors should be assessed a cut of 1 point each.

TEST I**Part 1. True and False**

1. _____ Each section chief must be informed of the minimum and maximum quadrants and the left and right deflection limits.
2. _____ It is safe to fire a projectile without a fuze.
3. _____ In direct fire, the chief of section must insure that minimum elevation limits are not violated.
4. _____ During heavy rain, the M514 fuze should not be fired.
5. _____ The chief of section will verify the serviceability of ammunition.
6. _____ Chemical and high-explosive projectiles can be stored together.
7. _____ Projectiles (and fuzes) that have been removed from a cannon by means of extraction should be fired on the next mission.
8. _____ Time fuzes previously set but not fired must be reset to safe.
9. _____ If the left deflection limit is 3650 mils, it is safe to fire a round at deflection 3700.

29. Which of the following diagrams illustrate correct sight pictures? Indicate your answer by placing an X in the appropriate spaces provided below.

- a. (1) _____ (2) _____ (3) _____
 b. (1) _____ (2) _____ (3) _____ (4) _____



30. List the actions taken in the event of a misfire on an M109/M109A1 howitzer (cold tube, charges 2 through 8).

Note. Requirements 31 through 33 are based on the safety T diagram shown below, which was computed for charge 4.

Max QE	417	
Deflection limits	3685	3315 2900
Min QE	209	177
Min safe FS M564	12.6	10.7
Min safe FS M514	19.0	17.0
Min QE (Ti & VT)	314	282

State whether the following data are safe or unsafe to fire; if unsafe, state why.

31. Lot XY, chg 4, fz quick, df 3695, QE 347.

32. Lot XY, chg 4, fz ti, 12.2, df 3472, QE 253.

33. Lot XY, chg 4, fz VT, 17.0, df 3515, QE 315.

34. List the action taken in the event of a misfire on an M109A1 howitzer (hot tube), charge 3.

35. Describe the method for measuring the greatest angle of site to a crest in front of the howitzer and list the five methods of determining piece-to-crest range.

SOLUTION I

Part 1. True and False

- | | | |
|----------|-----------|----------|
| 1. True | 6. False | 11. True |
| 2. False | 7. False | 12. True |
| 3. True | 8. True | 13. True |
| 4. True | 9. False | 14. True |
| 5. True | 10. False | 15. True |

Part 2. Multiple Choice

- | | |
|-------|-------|
| 16. d | 21. c |
| 17. c | 22. b |
| 18. a | 23. a |
| 19. b | 24. d |
| 20. a | 25. c |

Part 3. Completion

26. How are white phosphorus projectiles stored? Explain why.

They are stored with their bases down and away from other ammunition to prevent improper settling of the projectile filler.

27. If a VT fuze does not seat properly in the fuze well, what actions should be taken?

The fuze should be removed. Check the round to see if the supplementary charge is still in the fuze well. If it is, remove it, and install the fuze. If it still doesn't seat properly, remove it and turn it in to the ammunition section.

28. The method for placing out safety stakes is as follows:

Set on the sight, in turn, the left, intermediate, and right deflection limits determined from the safety card and take up a proper sight picture on the aiming point. Sight through the breech end of the tube and, sighting along the left edge of the tube for the left limit and the right edge of the tube for the right limit, align the safety stakes.

29. Which of the following sight diagrams illustrate correct sight pictures? Indicate your answer by placing an X in the appropriate spaces below.

- a. (2) b. (4)

30. List the actions taken in the event of a misfire on an M109/M109A1 howitzer (cold tube) charges 2 through 8.

After a failure to fire, actuate the firing mechanism two additional times in an attempt to fire. If the weapon still fails to fire, wait 2 minutes from the last attempt to fire and then remove and inspect the primer.

a. If the primer is not dented, the fault is in the firing mechanism. Repair the firing mechanism, prime and then fire the weapon.

b. If the primer is dented, the primer is at fault. Replace the primer with another primer and then fire the piece.

c. If the primer fired, the fault is with the propelling charge. Wait 10 minutes (8 minutes after removal and inspection of the primer), open the breech, and remove and dispose of the defective propelling charge. Reload the weapon with a new propelling charge and primer for firing.

State whether the following data are safe or unsafe to fire; if unsafe state why.

31. Unsafe, deflection exceeds left limit by 10 mils.

32. Unsafe, time is 0.4 second less than minimum time.

33. Unsafe, time is 2.0 seconds less than minimum time.

34. List the action taken in the event of a misfire on an M109A1 (hot tube) charge 3.

After a failure to fire, actuate the firing mechanism two additional times in an attempt to fire. If the weapon still fails to fire, wait 2 minutes from the last attempt to fire and then remove and inspect the primer.

a. If the primer is not dented, the fault is in the firing mechanism. Repair the firing mechanism, prime the weapon and then fire it within 5 minutes from the time the round was chambered.

b. If the primer is dented, the primer is at fault. Replace the primer with another primer and then fire the weapon within 5 minutes from the time the round is chambered.

c. If the primer fired, the fault is with the propelling charge. If it is a combat emergency, insert another primer and then attempt to fire the weapon within 5 minutes from the time the round was chambered.

d. If for any reason the projectile is not removed from the tube within 5 minutes of chambering, evacuate all personnel from the weapon and notify EOD for removal of the projectile.

35. Describe the method for measuring the greatest angle of site to a crest in front of the howitzer and list the five methods of determining piece-to-crest range.

Looking through the tube, sight along the lowest element of the bore and direct the movement of the tube until the line of site just clears the highest point on the crest in front of the howitzer. Center the cross-level and pitch-level bubbles and read the elevation, which is the greatest angle of site. The five methods of determining piece-to-crest range are MIL RELATION, TAPING, MAP MEASUREMENT, PACING, and ESTIMATION.

TEST II

Part 1. True and False

1. _____ The safety officer must compare the safety card minimum QE with the XO's minimum QE and use the larger as the minimum QE.

2. _____ In indirect fire, the safety officer must insure that the visible portion of the impact area is clear of personnel.

3. _____ The OIC may authorize the firing of all types of ammunition from a firing point, if he insures that the proper charge is being fired.

4. _____ Before illuminating rounds are fired, the safety officer must insure that the firing of those rounds is authorized on his safety card.

5. _____ The safety officer must insure that range clearance has been obtained before the battery may fire.

6. _____ CHECK FIRING will be commanded *only* by the safety officer.

7. _____ Firing will be halted when the range control commands CHECK FIRING.

8. _____ The safety officer will verify the boresight of each piece prior to firing in each position.

APPENDIX F

MINIMUM QE RAPID FIRE TABLES

F-1. General

These rapid fire tables include all the elements of the minimum QE discussed in chapter 10 *except* angle "a" (site to crest). Separate tables are included for each weapon/fuze/propellant combination. The value listed for elevation (EL) in all tables is the sum of the tabular firing table (TFT) elevation, 2 forks, the vertical angle corresponding to the appropriate vertical clearance, and the complementary angle of site for +300 mils angle of site. If the sum of the vertical angle and the complementary angle of site is greater than +300 mils, you will have to compute the data as shown in chapter 10.

The time (TI) listed in the VT fuze tables includes the TFT time of flight plus 5.5 seconds, expressed to the next higher whole second (min safe time) for each listed range. When the time set on the VT fuze is equal to or greater than the time listed in the table, the minimum quadrant elevation for fuzes *other than VT* is used. Vertical clearance for armed VT fuzes was determined with the vertical clearances prescribed for the M513, M514, and M728 fuzes.

F-2. Use of the Tables

a. Enter the table at the piece-to-crest range and determine the minimum elevation for the appropriate charge(s).

b. Select the greatest angle of site reported by the chiefs of section.

c. Add these two values. The sum is the minimum quadrant elevation.

EXAMPLE: 155-mm howitzer M109A1 range to the crest is 900 meters. Angles of site reported by the chiefs of section are +80, +78, +74, +68, +72, +79. Determine the minimum quadrant elevation for charge 5 white bag, fuze M564.

SOLUTION: Enter table V at range 900 meters.

Value from the table for charge 5	40
Greatest angle of site reported	+80 mils
Minimum quadrant elevation	+120 mils

THERE ARE RESTRICTIONS ON THE USE OF THE VT FUZE WHEN FIRING CERTAIN CHARGES ON SOME WEAPON SYSTEMS. THESE AREAS ARE INDICATED ON THE TABLES BY SHADING. FOR THE SPECIFIC RESTRICTIONS, REFER TO THE WEAPON-OPERATOR'S-MANUAL AND/OR TM 43-0001-28 (WHICH HAS SUPERSEDED TM 9-1300-203).

RAPID FIRE TABLE I

Range to Crest	FUZE M557, M564				PROPELLANT M67			Range to Crest	WEAPON M101A1				
	CHG 1	CHG 2	CHG 3	CHG 4	CHG 5	CHG 6	CHG 7		CHG 3	CHG 4	CHG 5	CHG 6	CHG 7
100	69	66	64	62	60	57	56	3700	603	396	269	193	134
200	57	52	48	44	41	36	33	3800	626	409	279	199	139
300	61	54	48	42	37	31	27	3900	647	421	287	207	143
400	73	61	54	46	39	31	25	4000	671	435	295	212	148
500	84	73	61	51	42	33	26	4500		541	350	245	173
600	100	87	73	58	46	36	27	5000		709	413	284	201
700	115	97	81	64	51	39	29	5500			490	324	229
800	128	108	90	73	55	43	30	6000			593	370	259
900	141	121	99	80	60	46	32	6500			757	423	292
1000	157	133	108	87	66	50	35	7000				488	329
1100	180	150	123	96	73	54	37	7500				569	369
1200	196	165	133	104	81	58	39	8000				684	414
1300	211	176	143	111	86	62	41	8500					465
1400	226	189	153	119	92	66	44	9000					529
1500	243	204	165	129	98	71	47	9500					609
1600	276	227	183	141	106	77	50	10000					734
1700	294	241	193	149	111	81	52						
1800	312	255	203	157	117	85	56						
1900	329	269	216	165	123	90	59						
2000	349	285	228	176	129	95	62						
2100	403	317	249	190	140	103	67						
2200	422	334	262	199	146	108	70						
2300	443	351	274	208	153	113	74						
2400	465	367	288	219	159	118	77						
2500	489	385	300	228	166	123	81						
2600	619	439	328	244	175	128	85						
2700	644	456	342	254	182	134	89						
2800	673	476	355	265	191	139	92						
2900	706	496	371	275	198	144	98						
3000	742	517	384	285	205	149	102						
3100	783	646	430	309	217	157	107						
3200		670	447	319	224	162	112						
3300		696	462	329	233	168	116						
3400		725	479	342	240	173	120						
3500		757	497	352	247	179	124						
3600		795	584	384	262	187	130						

RAPID FIRE TABLE VII

FUZE M557, M564

PROPELLANT WHITE BAG M2 (CHG 5-7), M188 (CHG 8)

WEAPON M110A1

Range to Crest	CHG 5	CHG 6	CHG 7	CHG 8	Range to Crest	CHG 5	CHG 6	CHG 7	CHG 8
100	56	55	55	54	3400	116	83	61	44
200	34	32	31	30	3500	120	86	63	46
300	27	25	24	22	3600	124	89	65	47
400	26	23	21	19	3700	128	91	67	49
500	26	23	20	18	3800	132	93	69	50
600	28	23	20	18	3900	136	97	71	51
700	30	24	20	18	4000	141	102	73	53
800	31	25	21	18	4500	163	119	83	60
900	33	26	21	18	5000	189	134	95	68
1000	36	28	23	19	5500	212	154	106	76
1100	38	29	24	19	6000	238	174	121	85
1200	41	31	26	20	6500	265	197	136	94
1300	43	32	26	20	7000	296	217	150	106
1400	45	34	28	21	7500	327	244	168	116
1500	48	36	29	22	8000	360	269	186	127
1600	51	38	31	23	8500	395	297	207	139
1700	53	40	31	23	9000	437	322	225	151
1800	57	42	33	25	9500	481	358	250	167
1900	60	44	34	26	10000	535	384	271	181
2000	63	47	36	27	10500	600	427	297	196
2100	67	51	38	29	11000	683	458	320	212
2200	70	53	39	30	11500		516	352	233
2300	74	55	41	31	12000		551	376	250
2400	77	58	43	33	12500		647	411	271
2500	80	60	44	34	13000		688	440	293
2600	84	62	45	34	13500			483	317
2700	87	64	47	35	14000			515	340
2800	91	66	49	37	14500			580	368
2900	94	69	51	38	15000			616	394
3000	99	72	52	39	15500			744	427
3100	104	75	55	41	16000			789	455
3200	108	78	57	42	16500				496
3300	112	80	59	43	17000				526
					17500				578
					18000				612
					18500				692
					19000				734

FUZE M514

PROPELLANT GREEN BAG M1

WEAPON M110A1

Range to	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5	
Crest	EL	Tl	EL	Tl	EL	Tl	EL	Tl	EL	Tl	Crest	EL	Tl	EL	Tl	EL	Tl	EL	Tl	EL	Tl
100	247	8.0	214	8.0	205	8.0	179	8.0	155	8.0	3400	372	21.0	301	19.0	241	18.0	198	17.0	154	15.0
200	247	8.0	214	8.0	205	8.0	179	8.0	155	8.0	3500	383	21.0	309	20.0	248	18.0	203	17.0	158	16.0
300	247	8.0	214	8.0	205	8.0	179	8.0	155	8.0	3600	400	22.0	318	20.0	258	18.0	212	17.0	164	16.0
400	247	8.0	214	8.0	205	8.0	179	8.0	155	8.0	3700	422	22.0	326	20.0	264	19.0	216	18.0	167	16.0
500	247	8.0	214	8.0	205	8.0	179	8.0	155	8.0	3800	433	23.0	333	21.0	271	19.0	220	18.0	170	17.0
600	221	8.0	214	8.0	205	8.0	179	8.0	155	8.0	3900	444	23.0	344	21.0	278	20.0	226	18.0	175	17.0
700	205	9.0	196	8.0	187	8.0	179	8.0	155	8.0	4000	457	24.0	360	22.0	284	20.0	230	19.0	178	17.0
800	195	9.0	185	9.0	174	9.0	165	8.0	155	8.0	3400	553	27.0	418	24.0	322	22.0	252	21.0	201	19.0
900	188	10.0	177	9.0	164	9.0	154	9.0	143	8.0	5000	698	30.0	491	27.0	368	24.0	289	22.0	225	21.0
1000	185	10.0	172	10.0	159	9.0	148	9.0	135	8.0	5500			585	30.0	419	26.0	299	24.0	249	22.0
1100	188	10.0	171	10.0	155	10.0	143	9.0	139	9.0	6000			726	33.0	479	29.0	360	26.0	274	24.0
1200	188	11.0	170	10.0	153	10.0	140	10.0	124	9.0	6500					555	31.0	405	28.0	303	26.0
1300	192	11.0	170	11.0	152	10.0	139	10.0	122	9.0	7000					657	34.0	453	30.0	333	28.0
1400	194	12.0	171	11.0	152	11.0	137	10.0	119	9.0	7500							510	33.0	369	30.0
1500	198	12.0	175	11.0	153	11.0	137	10.0	117	10.0	8000							578	35.0	405	32.0
1600	206	12.0	181	12.0	155	11.0	138	11.0	117	10.0	8500							670	38.0	445	34.0
1700	211	13.0	184	12.0	157	12.0	139	11.0	117	10.0	9000									493	36.0
1800	216	13.0	188	13.0	159	12.0	141	11.0	117	11.0	9500									547	38.0
1900	222	14.0	192	13.0	162	12.0	143	12.0	118	11.0	10000									615	41.0
2000	228	14.0	197	13.0	167	13.0	144	12.0	118	11.0	10500									707	43.0
2100	240	15.0	206	14.0	171	13.0	148	12.0	121	11.0											
2200	249	15.0	211	14.0	174	13.0	151	13.0	123	12.0											
2300	256	15.0	216	15.0	178	14.0	154	13.0	124	12.0											
2400	263	16.0	222	15.0	182	14.0	157	13.0	126	12.0											
2500	271	16.0	229	15.0	190	14.0	160	14.0	128	13.0											
2600	287	17.0	241	16.0	195	15.0	165	14.0	131	13.0											
2700	294	17.0	246	16.0	199	15.0	168	14.0	133	13.0											
2800	305	18.0	253	17.0	204	16.0	172	15.0	135	14.0											
2900	314	18.0	259	17.0	209	16.0	176	15.0	138	14.0											
3000	321	19.0	265	17.0	216	16.0	179	15.0	140	14.0											
3100	342	19.0	278	18.0	226	17.0	186	16.0	145	14.0											
3200	351	20.0	287	18.0	231	17.0	190	16.0	148	15.0											
3300	363	20.0	294	19.0	236	17.0	194	16.0	151	15.0											

RAPID FIRE TABLE VII

FUZE M514

PROPELLANT WHITE BAG M2 (CHG 5-7), M188 (CHG 8)

WEAPON M110A1

Range to Crest	CHG 5		CHG 6		CHG 7		CHG 8		Range to Crest	CHG 5		CHG 6		CHG 7		CHG 8		
	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	
100	140	8.0	124	8.0	106	8.0	90	8.0	3400	144	15.0	111	14.0	89	12.0	72	11.0	
200	140	8.0	124	8.0	106	8.0	90	8.0	3500	148	15.0	114	14.0	91	13.0	74	12.0	
300	140	8.0	124	8.0	106	8.0	90	8.0	3600	151	16.0	116	14.0	92	13.0	74	12.0	
400	140	8.0	124	8.0	106	8.0	90	8.0	3700	154	16.0	117	14.0	93	13.0	75	12.0	
500	140	8.0	124	8.0	106	8.0	90	8.0	3800	157	16.0	119	15.0	94	13.0	75	12.0	
600	140	8.0	124	8.0	106	8.0	90	8.0	3900	161	16.0	122	15.0	96	13.0	76	12.0	
700	140	8.0	124	8.0	106	8.0	90	8.0	4000	165	17.0	126	15.0	97	14.0	77	12.0	
800	140	8.0	124	8.0	106	8.0	90	8.0	4500	184	18.0	140	16.0	104	15.0	81	13.0	
900	140	8.0	124	8.0	106	8.0	90	8.0	5000	208	20.0	153	18.0	114	16.0	87	14.0	
1000	132	8.0	124	8.0	106	8.0	90	8.0	5500	230	22.0	172	19.0	124	17.0	94	15.0	
1100	126	9.0	117	8.0	106	8.0	90	8.0	6000	254	23.0	190	21.0	137	19.0	101	16.0	
1200	121	9.0	111	8.0	106	8.0	90	8.0	6500	280	25.0	212	23.0	151	20.0	109	18.0	
1300	118	9.0	107	9.0	101	8.0	90	8.0	7000	310	27.0	231	24.0	164	21.0	119	19.0	
1400	114	9.0	103	9.0	97	8.0	90	8.0	7500	340	29.0	257	26.0	181	23.0	129	20.0	
1500	112	10.0	100	9.0	93	9.0	86	8.0	8000	372	31.0	281	28.0	198	24.0	139	21.0	
1600	111	10.0	98	9.0	91	9.0	83	8.0	8500	406	33.0	308	30.0	218	26.0	150	23.0	
1700	110	10.0	97	9.0	88	9.0	80	8.0	9000	448	35.0	333	31.0	236	28.0	162	24.0	
1800	111	10.0	96	10.0	87	9.0	79	9.0	9500	491	37.0	368	33.0	260	30.0	177	25.0	
1900	111	11.0	95	10.0	85	9.0	77	9.0	10000	544	39.0	394	35.0	281	31.0	191	27.0	
2000	111	11.0	95	10.0	84	9.0	75	9.0	10500	609	41.0	436	37.0	306	33.0	205	28.0	
2100	113	11.0	97	10.0	84	10.0	75	9.0	11000	692	44.0	467	39.0	329	35.0	221	30.0	
2200	114	11.0	97	11.0	83	10.0	74	9.0	11500			524	41.0	360	37.0	241	32.0	
2300	116	12.0	97	11.0	83	10.0	73	9.0	12000			559	44.0	384	39.0	258	33.0	
2400	117	12.0	98	11.0	83	10.0	73	10.0	12500			655	46.0	419	41.0	279	35.0	
2500	118	12.0	98	11.0	82	10.0	72	10.0	13000			695	49.0	447	43.0	300	37.0	
2600	122	13.0	100	12.0	83	11.0	72	10.0	13500					490	45.0	324	39.0	
2700	123	13.0	100	12.0	83	11.0	71	10.0	14000					522	47.0	347	41.0	
2800	126	13.0	101	12.0	84	11.0	72	10.0	14500					587	49.0	375	43.0	
2900	128	13.0	103	12.0	85	11.0	72	10.0	15000					622	52.0	400	45.0	
3000	131	14.0	104	12.0	85	11.0	72	11.0	15500					750	54.0	433	47.0	
3100	135	14.0	105	13.0	86	12.0	72	11.0	16000					795	57.0	461	49.0	
3200	138	14.0	108	13.0	87	12.0	72	11.0	16500							502	51.0	
3300	141	15.0	109	13.0	88	12.0	72	11.0	17000							531	53.0	
									17500								583	56.0
									18000								617	58.0
									18500								697	61.0
									19000								739	64.0
NOTE: No restrictions.																		

NOTE: No restrictions.

RAPID FIRE TABLE VII

FUZE M728

PROPELLANT GREEN BAG M1

WEAPON M110A1

Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5		Range to Crest	CHG 1		CHG 2		CHG 3		CHG 4		CHG 5	
	EL	TI	EL	TI	EL	TI	EL	TI	EL	TI		EL	TI	EL	TI	EL	TI	EL	TI	EL	TI
100	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3400	363	21.0	292	19.0	232	18.0	189	17.0	145	15.0
200	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3500	374	21.0	300	20.0	239	18.0	194	17.0	149	16.0
300	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3600	391	22.0	309	20.0	249	18.0	203	17.0	155	16.0
400	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3700	416	22.0	318	20.0	256	19.0	208	18.0	159	16.0
500	186	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3800	425	23.0	325	21.0	263	19.0	212	18.0	162	17.0
600	170	8.0	163	8.0	154	8.0	135	8.0	117	8.0	3900	436	23.0	336	21.0	270	20.0	218	18.0	167	17.0
700	161	9.0	152	8.0	143	8.0	135	8.0	117	8.0	4000	449	24.0	352	22.0	276	20.0	222	19.0	170	17.0
800	157	9.0	147	9.0	136	9.0	127	8.0	117	8.0	4500	546	27.0	411	24.0	315	22.0	245	21.0	194	19.0
900	155	10.0	144	9.0	131	9.0	121	9.0	110	8.0	5000	692	30.0	485	27.0	362	24.0	283	22.0	219	21.0
1000	155	10.0	142	10.0	129	9.0	118	9.0	105	8.0	5500			579	30.0	413	26.0	293	24.0	243	22.0
1100	160	10.0	143	10.0	127	10.0	115	9.0	101	9.0	6000			721	33.0	474	29.0	355	26.0	269	24.0
1200	163	11.0	145	10.0	128	10.0	115	10.0	99	9.0	6500					550	31.0	400	28.0	298	26.0
1300	168	11.0	147	11.0	128	10.0	115	10.0	98	9.0	7000					653	34.0	449	30.0	329	28.0
1400	172	12.0	149	11.0	130	11.0	115	10.0	97	9.0	7500							506	33.0	365	30.0
1500	178	12.0	155	11.0	133	11.0	117	10.0	97	10.0	8000							574	35.0	401	32.0
1600	187	12.0	162	12.0	136	11.0	119	11.0	98	10.0	8500							667	38.0	442	34.0
1700	193	13.0	166	12.0	139	12.0	121	11.0	99	10.0	9000									489	36.0
1800	199	13.0	171	13.0	142	12.0	124	11.0	100	11.0	9500									544	38.0
1900	206	14.0	176	13.0	146	12.0	127	12.0	102	11.0	10000									612	41.0
2000	213	14.0	182	13.0	152	13.0	129	12.0	105	11.0	10500									704	43.0
2100	225	15.0	191	14.0	156	13.0	133	12.0	106	11.0											
2200	235	15.0	197	14.0	160	13.0	137	13.0	109	12.0											
2300	243	15.0	203	15.0	165	14.0	141	13.0	111	12.0											
2400	250	16.0	209	15.0	169	14.0	144	13.0	113	12.0											
2500	259	16.0	217	15.0	178	15.0	148	14.0	116	13.0											
2600	275	17.0	229	16.0	183	15.0	153	14.0	119	13.0											
2700	283	17.0	235	16.0	188	16.0	157	14.0	122	13.0											
2800	294	18.0	242	17.0	193	16.0	161	15.0	124	14.0											
2900	303	18.0	248	17.0	198	16.0	165	15.0	127	14.0											
3000	311	19.0	255	17.0	206	16.0	169	15.0	130	14.0											
3100	333	19.0	269	18.0	217	17.0	177	16.0	136	14.0											
3200	342	20.0	278	18.0	222	17.0	181	16.0	139	15.0											
3300	354	20.0	285	19.0	227	17.0	185	16.0	142	15.0											

NOTE: No restrictions.

RAPID FIRE TABLE VII

FUZE M728

PROPELLANT WHITE BAG M2 (CHG 5-7), M188 (CHG 8)

WEAPON M110A1

Range to	CHG 5		CHG 6		CHG 7		CHG 8		Range to	CHG 5		CHG 6		CHG 7		CHG 8		
Crest	EL	TI	EL	TI	EL	TI	EL	TI	Crest	EL	TI	EL	TI	EL	TI	EL	TI	
100	107	8.0	94	8.0	81	8.0	68	8.0	3400	135	15.0	102	14.0	80	12.0	63	11.0	
200	107	8.0	94	8.0	81	8.0	68	8.0	3500	139	16.0	105	14.0	82	13.0	65	12.0	
300	107	8.0	94	8.0	81	8.0	68	8.0	3600	142	16.0	107	14.0	83	13.0	65	12.0	
400	107	8.0	94	8.0	81	8.0	68	8.0	3700	146	16.0	109	15.0	85	13.0	67	12.0	
500	107	8.0	94	8.0	81	8.0	68	8.0	3800	149	17.0	111	15.0	86	13.0	67	12.0	
600	107	8.0	94	8.0	81	8.0	68	8.0	3900	153	17.0	114	15.0	88	14.0	68	12.0	
700	107	8.0	94	8.0	81	8.0	68	8.0	4000	157	17.0	118	16.0	89	14.0	69	12.0	
800	107	8.0	94	8.0	81	8.0	68	8.0	4500	176	19.0	133	17.0	97	15.0	74	13.0	
900	107	8.0	94	8.0	81	8.0	68	8.0	5000	202	21.0	147	18.0	108	16.0	81	14.0	
1000	102	8.0	94	8.0	81	8.0	68	8.0	5500	224	22.0	166	20.0	118	18.0	88	15.0	
1100	98	9.0	89	8.0	81	8.0	68	8.0	6000	249	24.0	185	22.0	132	19.0	96	16.0	
1200	96	9.0	86	8.0	81	8.0	68	8.0	6500	275	26.0	207	23.0	146	20.0	104	18.0	
1300	94	9.0	83	9.0	77	8.0	68	8.0	7000	306	28.0	227	25.0	160	22.0	115	19.0	
1400	92	10.0	81	9.0	75	8.0	68	8.0	7500	336	30.0	253	27.0	177	23.0	125	20.0	
1500	92	10.0	80	9.0	73	9.0	66	8.0	8000	368	32.0	277	29.0	194	25.0	135	21.0	
1600	92	10.0	79	9.0	73	9.0	64	8.0	8500	403	34.0	305	30.0	215	27.0	147	23.0	
1700	92	10.0	79	10.0	70	9.0	62	8.0	9000	444	36.0	328	32.0	232	28.0	158	24.0	
1800	94	11.0	79	10.0	70	9.0	62	9.0	9500	488	39.0	365	34.0	257	30.0	164	25.0	
1900	95	11.0	79	10.0	69	9.0	61	9.0	10000	541	41.0	391	36.0	278	32.0	188	27.0	
2000	96	11.0	80	10.0	69	10.0	60	9.0	10500	606	44.0	433	38.0	303	34.0	202	28.0	
2100	98	11.0	82	11.0	69	10.0	60	9.0	11000			464	41.0	326	35.0	218	30.0	
2200	100	12.0	83	11.0	69	10.0	60	9.0	11500			522	43.0	358	37.0	239	32.0	
2300	103	12.0	84	11.0	70	10.0	60	9.0	12000			556	45.0	381	39.0	256	33.0	
2400	104	12.0	85	11.0	70	10.0	60	10.0	12500			652	48.0	416	41.0	277	35.0	
2500	106	13.0	86	12.0	70	11.0	60	10.0	13000					445	44.0	298	37.0	
2600	110	13.0	88	12.0	71	11.0	60	10.0	13500					488	46.0	322	39.0	
2700	112	13.0	89	12.0	72	11.0	60	10.0	14000					520	48.0	345	41.0	
2800	115	14.0	90	12.0	73	11.0	61	10.0	14500					584	50.0	372	43.0	
2900	117	14.0	92	13.0	74	11.0	61	10.0	15000					620	53.0	398	45.0	
3000	121	14.0	94	13.0	74	12.0	61	11.0	15500							431	47.0	
3100	126	14.0	97	13.0	77	12.0	63	11.0	16000							459	49.0	
3200	129	15.0	99	13.0	78	12.0	63	11.0	16500							500	51.0	
3300	132	15.0	100	14.0	79	12.0	63	11.0	17000							530	53.0	
									17500								582	56.0
									18000								615	58.0
									18500								695	61.0
									19000								737	64.0

NOTE: No restrictions.

NOTE: No restrictions.

RAPID FIRE TABLE VIII

FUZE M572

PROPELLANT M124 (Green Bag)
M86 Series (White Bag)

WEAPON M107

Range to Crest	CHG 1	CHG 2	CHG 3	Range to Crest	CHG 1	CHG 2	CHG 3	Range to Crest	CHG 2	CHG 3
100	12	10	7	3300	82	42	23	16500	421	184
200	10	7	4	3400	84	43	24	17000	446	194
300	12	8	4	3500	87	44	24	17500	484	204
400	14	9	5	3600	90	46	25	18000	512	216
500	16	10	5	3700	92	47	26	18500	559	225
600	17	10	5	3800	95	48	27	19000	590	237
700	19	11	6	3900	98	50	27	19500	659	246
800	21	12	6	4000	101	51	28	20000	696	261
900	23	13	7	4500	117	58	30	20500		272
1000	25	14	8	5000	132	67	39	21000		285
1100	28	15	8	5500	152	76	43	21500		298
1200	31	16	9	6000	169	84	48	22000		314
1300	33	17	9	6500	191	92	52	22500		327
1400	35	18	10	7000	210	100	57	23000		343
1500	37	19	11	7500	234	110	61	23500		359
1600	39	20	11	8000	257	120	66	24000		376
1700	41	22	12	8500	285	132	72	24500		392
1800	44	23	13	9000	308	142	77	25000		411
1900	46	24	13	9500	340	154	81	25500		430
2000	48	25	14	10000	368	166	87	26000		448
2100	51	27	15	10500	405	181	92	26500		471
2200	54	28	15	11000	433	193	99	27000		491
2300	56	29	16	11500	484	208	105	27500		518
2400	58	31	17	12000	516	224	112	28000		542
2500	61	32	17	12500	588	241	118	28500		574
2600	63	33	18	13000	626	259	125	29000		599
2700	66	34	19	13500	771	277	134	29500		647
2800	68	35	19	14000		297	142	30000		675
2900	71	37	20	14500		321	150	30500		757
3000	73	38	21	15000		340	158	31000		791
3100	77	39	22	15500		367	166			
3200	79	40	22	16000		390	176			

APPENDIX H

STANDARDIZATION AGREEMENT 2047

H-1. General

a. Standardization Agreements (STANAG) are international (NATO, SEATO, CENTO) agreements designed to facilitate allied operations. Upon ratification by the United States, a STANAG is binding upon US Armed Forces (entirely or with exceptions as noted). This appendix provides information on the STANAG implemented in this manual, STANAG 2047 (EDITION NO. 2), EMERGENCY ALARMS OF HAZARD OR ATTACK.

b. It is agreed that the NATO Armed Forces, when operating on land, are to use the sounds and signals detailed herein to give emergency alarms of—

- (1) Nuclear, biological or chemical (NBC) hazards and friendly nuclear strikes.
- (2) Air attack.
- (3) Ground attack.

H-2. Definitions

For the purpose of this agreement, the following definitions apply:

a. *Nuclear, biological, or chemical (NBC) hazards and friendly nuclear strikes.* The presence of biological or chemical agents or radioactive matter in the vicinity of friendly troops, whether as a result of enemy or friendly action.

b. *Air attack.* The direct attack on friendly troops by aircraft or the imminent possibility thereof.

c. *Ground attack.* Any attack in platoon strength or greater into the sector (area) of a friendly unit.

d. *Friendly nuclear strike.* The employment of nuclear weapons by friendly forces that necessitates emergency alarms to friendly troops who might be affected.

e. *Local alarm.* An alarm given in all cases when an attack or the presence of a hazard is detected. This alarm is given by any means available that produces a sound that cannot be confused with other sounds encountered in combat. Visual signals are also used.

f. *General warning.* A warning given when the hazard or attack is expected to involve a large area. The general warning is sent out by all normal means of communication to all areas that may be affected.

g. *All clear.* A signal given to indicate that the danger for which an alarm has previously been given no longer exists.

H-3. General Provisions

a. Sound and visual signals to be used for emergency alarms of hazard or attack and the all clear—

- (1) Are designated for use in installations, depots, headquarters, or units of battalion size or smaller.
- (2) Are suitable for use in both forward and rear areas.

(3) Are given in all cases as soon as an attack or the presence of a hazard is detected. This alarm is given by means that cannot be confused easily with other sounds encountered in combat. Visual signals are also used.

(4) Normally should be supplemented by the simultaneous use of radio and telephone.

(5) Generally are limited in range and should be repeated swiftly throughout the unit area by all who hear or see the original alarm.

b. No attempt has been made to make the types of signals described in this agreement coincide with the types of signals that may be used in civilian defense.

c. Visual signals are included in this agreement to supplement the sound alarms under conditions when the latter may be lost as a result of other battlefield noises or to replace them if the tactical situation does not permit the use of sound signals.

d. The signals listed in the STANAG are primarily intended to serve as alarms of enemy action. They may also be used, however, in emergencies when friendly action could produce similar effects on friendly troops.

H-4. Specific Signals

a. Nuclear, biological, chemical (NBC) hazard.

(1) *By percussion.* Rapid and continuous beating on any metal object or any other object that produces a loud noise, such as bells, a metal triangle, an iron railing, iron pipes, empty shell cases, mess tins, steel helmets, and vehicle bodies.

(2) *Horns and sirens.* (When not prohibited by national authority.) A horn signal of three short blasts followed by 2 seconds of silence with the signal to be repeated for 1 minute. A siren of three long warbling sounds, each separated by a silence.

(3) *Vocal alarm.* Shout "gas" or "spray" as appropriate.

(4) *Automatic alarms.* Automatic alarms for the early and rapid detection of chemical agents should, as much as possible, replace the improvised devices referred to above.

b. Air attack (notes 1 and 2 below).

(1) *Sound signals.* Continuous series of short blasts on a vehicle horn, a whistle, a bugle, or other available wind instrument. Give a long blast on the siren, with a warbling sound (when not prohibited by national authority).

(2) *Visual signals.* Rapid crossing and uncrossing of the arms fully extended above the head.

c. Ground attack (notes 1 and 2).

(1) *Sound signals.* Series of long blasts on a vehicle horn, whistle, bugle, or other available wind instrument.

(2) *Visual signals.* None—unless prescribed in national or local instructions.

d. Friendly nuclear strikes (note 2).

(1) *Sound signals.* As prescribed in national or local instructions.

(2) *Visual signals.* As prescribed in national or local instructions.

e. Signals for the all clear (note 2). Release from an alarm state normally should be given orally, but when circumstances permit, the following sound signal may be used: A continuous

sustained blast on a vehicle horn, a whistle, a bugle, or other other wind instrument or a siren signal with a continous steadily pitched blast 1 minute in duration.

Notes.

1. If an air or ground attack is determined to be a nuclear, biological, or chemical hazard, the appropriate NBC hazard alarm should replace or immediately follow the air or ground attack alarm as appropriate.

2. The spoken word (vocal alarm) remains the most effective means of informing troops in an emergency.



APPENDIX I

MAINTENANCE AIDS

I-1. Correspondence and OJT Programs

Table I-1 is a list of some typical maintenance MOSs for which OJT programs may be necessary and the proponent agencies for these courses. The commander may wish to refer to DA Pam 351-20 for further correspondence courses.

Table I-1. Correspondence/OJT Programs

POSITION	COURSE TITLE	ADDRESS-APPLICATION OR CATALOG
Mechanic	Wheeled Vehicle Mechanic Correspondence/OJT Course Tracked Vehicle Mechanic Correspondence/OJT Course	Army Correspondence Course Program (191) US Army Training Support Center Newport News, VA 23628
Equip maint clerk	Equipment Maintenance Clerk Correspondence/OJT Course	
	Unit and Organizational Maintenance, Repair Parts Supply, and Storage Correspondence Course, Course 159	(101)
Power generator operator/mechanic	Power Generator Operations I, II, III, IV, and V	(051)
Battery motor officer	Motor Officer Course	(171)

I-2. Maintenance Training Publications

The following publications are sources of information for an OJT program for personnel in the battery or battalion shop.

Table I-2. Maintenance Training Publications

PUBLICATION	TITLE
DA Pam 350-25-1	Track Vehicle Mechanic Course, Combat Vehicles, Armored Carrier, M113/M113A1

NOTE: Refer to DA Pam 310-3 and DA Pam 310-4 for additional maintenance training publications that are applicable to pertinent battery or battalion shop.

I-3. Operator Training

a. A good operator training program is frequently difficult to organize and operate. Knowing where to start can be of assistance to the commander. The DA publications required to conduct an operator's training program are listed in table I-3.

Table I-3. Driver Selection/Testing Publications

PUBLICATION	TITLE
AR 600-55	Motor Vehicle Driver-Selection, Testing and Licensing.
AR 600-58	Mechanical Equipment Operator-Selection, Training, Testing, and Licensing.
TM 21-300	Driver Selection and Training (Wheeled Vehicles).
TM 21-301	Driver Selection, Training, and Supervision; Tracked Vehicles.
FM 21-305	Manual for the Wheeled Vehicle Driver.
TM 21-306	Manual for the Tracked Combat Vehicle Driver.
TB 600-1	Procedures for Licensing Operators of Equipment Managed by the US Army Mobility Equipment Command.

b. A suggested list of tasks that may be used to train operator personnel prior to their being licensed is outlined below.

Table I-4. Vehicle Operator Qualification Tasks

PROSPECTIVE DRIVER'S NAME: _____

DATE COMPLETED INITIAL TESTING: _____

SECTION CHIEF: _____

TASK	REFERENCE	GO	NO GO	INIT
Perform before-operation checks and services on vehicle.	Operator's manual			
Perform during-operation checks and services on vehicle.	Operator's manual			
Perform after-operation checks and services on vehicle.	Operator's manual			
Prepare vehicle for tactical operations.	Operator's manual			
Prepare vehicle for operation in snow/ice.	Operator's manual			
Start the engine by using the vehicle's power source.	Operator's manual			
Start the engine by using auxiliary power from an outside source.	Operator's manual			
Start the engine of a vehicle by towing.	Operator's manual			

Table I-4. Vehicle Operator Qualification Tasks—Continued

TASK	REFERENCE	GO	NO GO	INIT
Start the engine of vehicle in extremely cold weather (real or simulated).	Operator's manual			
Operate a vehicle over various types of terrain.	Operator's manual, Unit SOP			
Operate a vehicle under blackout conditions.	Operator's manual			
Operate a vehicle while backing with a trailer.	Operator's manual			
Guide a vehicle during daylight by using hand and arm signals.	FM 21-60			
Guide a vehicle during the hours of darkness by using a flashlight.	FM 21-60			
Extinguish a fire in a vehicle by using emergency procedures.	Operator's manual			
Recover a mired vehicle by using expedient means.	FM 21-305, FM 20-22			
Troubleshoot malfunctions by using the operator's manual.	Operator's manual			
Inventory basic issue items.	Operator's manual			
Perform preventive maintenance on basic issue items.	Operator's manual			
Fill out DA Form 2408-1 (daily) for a day of operation.	TM 38-750			
Fill out heading of DA Form 2404 used to record results of operator's daily inspection.	TM 38-750			
Fill out DA Form 2404 for operator's daily inspection to indicate no new uncorrected faults discovered on vehicle.	TM 38-750			
Fill out DA Form 2404 for operator's daily inspection to annotate a fault the operator cannot correct himself.	TM 38-750			
Fill out operator's portion of DA Form 2400 for day of operation.	TM 38-750			
Fill out DD Form 518, Accident Identification Card.	FM 21-305			
Fill out SF 91, Operator's Report of Motor Vehicle Accident, for simulated motor vehicle accident.	FM 21-305			

Table I-4. Vehicle Operator Qualification Tasks—Continued

TASK	REFERENCE	GO	NO GO	INIT
Perform ESC evaluation of vehicle.	ESC technical manual			
Record results of ESC evaluation on DA Form 2404.	ESC technical manual and TM 38-750			
Read vehicle lubrication order to specify lubrication points, intervals, and lubricants.	Vehicle LO			

Note. The individual being tested should actually perform the task stated if at all practical. Attendance at a class on the task does NOT necessarily indicate proficiency. The prospective driver should be allowed to use any reference he normally would have with the vehicle during dispatch (e.g., operator's manual, FM 21-305, lubrication order, and logbook).

The above named individual has performed the tasks specified above and is recommended as a wheeled/tracked vehicle driver.

(Signature of section chief)

(Date)

I have interviewed the above named individual, familiarized him with his duties as a wheeled/tracked vehicle driver, and recommend that he be issued this driver's license.

(Signature of Motor Officer)

(Date)

c. Additional aids the unit may wish to use while establishing the operator training program are listed below.

Table I-5. Driver Training Program Aids

PUBLICATION	TITLE
DA Pam 750-31	The M561 Gama Goat—Operation and Preventive Maintenance.
TB 9-2320-218-10-1	Safe Operation of Truck, Utility, 1/4-Ton, 4x4, M151 Series.

I-4. Forms for Pinpoint Accounts

Table I-6. Forms of the DA Form 12-Series

DA Form Number	Title
12	Request for Establishment of a Publications Account.
12-4	Requirements for Department of the Army Administrative Publications other than Regulations and Circulars.
12-5	Requirements for Department of the Army Periodicals.
12-8	Requirements for Allied Communication Publications (ACP) and Joint Army, Navy, Air Force Publications (JANAP).
12-9A	Requirements for Department of the Army Unclassified Administrative Publications (AR's, CIR's, PAM's).
12-9B	Requirements for Department of the Army Administrative Publications (AR's, CIR's, PAM's).
12-11	Instructions for Completion of DA Form 12-11A and DA Form 12-11B (Army Doctrinal Publications) (FM).
12-11A	Requirements for Army Doctrinal Publications (FM).
12-11B	Requirements for Army Doctrinal Publications (FM).
12-12	Requirements for Tables of Organization and Equipment and Training Publications.
12-21	Requirements for Federal and Department of the Army Supply Catalogs.
12-21A	Requirements for Federal and Department of the Army Supply Catalogs.
12-25	Instructions for Completion of DA Forms 12-25A, 12-25B, 12-25C, and 12-25D (Technical Publications for Army Mobility Support, Construction, Environmental, Electrical Generating, Rail, Marine, and Amphibious Equipment).
12-25A	Requirements for Technical Publications for Army Mobility Support Equipment.
12-25B	Requirements for Technical Publications for Army Construction Equipment.
12-25C	Requirements for Technical Publications for Army Environmental Equipment.
12-25D	Requirements for Technical Publications for Army Electrical Generating, Rail, Marine, and Amphibious Equipment.
12-28	Requirements for Army Chemical Equipment Publications.
12-31	Requirements for Army Aviation and Army Avionic Configuration Publications.
12-32	Requirements for Army Missile, Rocket, and Air Defense Fire Distribution Systems Publications.
12-34	Requirements for Department of the Army Supply Bulletins.
12-34A	Requirements for Department of the Army Technical Bulletins.
12-34B	Requirements for Department of the Army Non-equipment Technical Manuals.
12-35	Requirements for Nuclear Weapons Publications.
12-36	Instructions for Completion of DA Form 12-36A (Avionics Publications).
12-36A	Requirements for Army Avionics Publications.
12-37	Requirements for Army Operation and Maintenance Literature for Combat Vehicles.
12-38	Requirements for Army Automotive Publications—Trucks.

Table I-6. Forms of the DA Form 12-Series—Continued

DA Form Number	Title
12-39	Requirements for Department of the Army Automotive Publications—Dollies, Trailers, and Semitrailers.
12-40	Requirements for Army Artillery, Small Arms, and Conventional Ammunition Technical Publications.
12-41	Requirements for Sighting and Fire Control Equipment Publications.
12-43	Requirements for Army Communications Security (COMSEC) Materiel Technical Publications.
12-50	Requirements for Army Radiac and Fixed Radio Equipment Technical Publications.
12-51	Requirements for Army Communication Electronics Equipment Literature.

I-5. Suggested Minimum Motor Pool Library

Each battalion (battery) maintenance section should maintain a library of current maintenance publications for ready reference by operators and maintenance personnel. The following is a list of publications that are recommended for an effective maintenance program. Additional publications should be provided to meet special requirements.

a. Army regulations (AR).

- (1) AR 11-14, *Logistic Readiness*.
- (2) AR 55-29, *Military Convoy Operations in CONUS*.
- (3) AR 220-1, *Unit Readiness Reporting*.
- (4) AR 220-10, *Preparation for Oversea Movement of Units (POM)*.
- (5) AR 310-1, *Publications, Blank Forms, and Printing Management*.
- (6) AR 310-25, *Dictionary of United States Army Terms (Short Title: AD)*.
- (7) AR 310-50, *Authorized Abbreviations and Brevity Codes*.
- (8) AR 340-1, *Records Management—Program Policies and Procedures*.
- (9) AR 340-18-14, *Maintenance and Disposition of Logistics Functional Files*.
- (10) AR 385-10, *Army Safety Program*.
- (11) AR 385-30, *Safety Color Code Markings and Signs*.
- (12) AR 385-40, *Accident Reporting and Records*.
- (13) AR 385-55, *Prevention of Motor Vehicle Accidents*.
- (14) AR 600-55, *Motor Vehicle Driver—Selection, Testing, and Licensing*.
- (15) AR 600-58, *Mechanical Equipment Operator—Selection, Training, Testing, and Licensing*.
- (16) AR 700-4, *Logistic Assistance Program*.
- (17) AR 700-68, *Compressed Gases and Gas Cylinders*.
- (18) AR 710-2, *Materiel Management for Using Units, Support Units, and Installations*.
- (19) AR 735-5, *General Principles, Policies, and Basic Procedures*.

- (20) AR 735-11, *Accounting for Lost, Damaged, and Destroyed Property.*
- (21) AR 746-1, *Color, Marking, and Preparation of Equipment for Shipment.*
- (22) AR 750-1, *Army Materiel Maintenance Concepts and Policies.*
- (23) AR 750-20, *Prevention, Control, and Abatement of Pollution from Mobile Equipment.*
- (24) AR 750-37, *Sample Data Collection—The Army Maintenance Management System (TAMMS).*
- (25) AR 750-43, *Test, Measurement, and Diagnostic Equipment.*
- (26) AR 750-51, *Maintenance Assistance and Instruction Team (MAIT) Program.*
- (27) AR 750-52, *Equipment Operationally Ready Standards.*

b. Department of the Army Pamphlets (DA Pam).

- (1) DA Pamphlet 310-1, *Index of Administrative Publications.*
- (2) DA Pamphlet 310-2, *Index of Blank Forms.*
- (3) DA Pamphlet 310-3, *Index of Doctrinal, Training, and Organizational Publications.*
- (4) DA Pamphlet 310-4, *Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.*
- (5) DA Pamphlet 310-6, *Index of Supply Catalogs and Supply Manuals (Excluding Types 7, 8, and 9).*
- (6) DA Pamphlet 310-7, *Military Publications: US Army Equipment Index of Modification Work Orders.*
- (7) DA Pamphlet 310-13, *Military Publications: Posting and Filing Publications.*

c. Technical Manuals (TM).

- (1) TM 5-461, *Engineer Handtools.*
- (2) TM 5-725, *Rigging.*
- (3) TM 9-237, *Operator's Manual: Welding Theory and Application.*
- (4) TM 9-243, *Use and Care of Handtools and Measuring Tools.*
- (5) TM 9-500, *Data Sheets for Ordnance Type Materiel.*
- (6) TM 9-1000-202-14, *Evaluation of Cannon Tubes.*
- (7) TM 9-2530-200-24, *Organizational, Direct Support and General Support Maintenance Manual: Standards for Inspection and Classification of Tracks, Track Components and Solid-Rubber Tires.*
- (8) TM 9-2610-200-20, *Organizational Care, Maintenance and Repair of Pneumatic Tires and Inner Tubes.*
- (9) TM 9-2610-201-14, *Standard and Criteria for Technical Inspection and Classification of Tires.*
- (10) TM 9-2610-201-14-1, *Visual Guide for Technical Inspection and Classification of Tires.*
- (11) TM 9-4910-496-10, *Operator's Manual: Towbar, Motor Vehicle.*
- (12) TM 9-6140-200-12, *Operator and Organizational Maintenance Manual for Lead-Acid Storage Batteries.*
- (13) TM 9-8000, *Principles of Automotive Vehicles.*
- (14) TM 21-300, *Driver Selection and Training (Wheeled Vehicles).*
- (15) TM 21-301, *Driver Selection, Training, and Supervision; Tracked Vehicles.*

- (16) TM 21-306, *Manual for the Tracked Combat Vehicle Driver.*
- (17) TM 38-750, *The Army Maintenance Management System (TAMMS).*
- (18) TM 43-0139, *Painting Instructions for Field Use.*
- (19) TM 55-601, *Railcar Loading Procedures.*
- (20) TM 55-603, *Movement of Military Impedimenta by Commercial Carriers.*
- (21) TM 55-604, *Troop Movement Guide.*
- (22) TM 740-90-1, *Administrative Storage of Equipment.*
- (23) TM 750-116, *Organizational, Direct Support, and General Support Maintenance Procedures for Purging and Charging of Fire Control Instruments.*

Technical manual for each type of equipment supported.

Equipment serviceability criteria (ESC) manual for each type of equipment.

d. Supply Manuals (SM).

- (1) DOD supply manual for each type of common tool kit authorized.
- (2) Current Army Management Data File (AMDF).

e. Miscellaneous publications.

- (1) Technical bulletins (TB), modification work orders (MWO), and lubrication orders (LO) for each type of equipment supported.
- (2) Unit Maintenance standing operating procedures (SOP).
- (3) Self-Service supply center catalog.
- (4) Direct exchange list.
- (5) Quick supply store catalog.
- (6) Direct Support Unit SOP.

f. Other publications.

- (1) FM 5-20, *Camouflage.*
- (2) FM 5-36, *Route Reconnaissance and Classification.*
- (3) FM 10-14, *Unit and Organization Supply (Manual Procedures).*
- (4) FM 10-69, *Petroleum Supply Point Equipment and Operations*
- (5) FM 20-22, *Vehicle Recovery Operations.*
- (6) FM 21-6, *How to Prepare and Conduct Military Training.*
- (7) FM 21-11, *First Aid for Soldiers.*
- (8) FM 21-26, *Map Reading.*
- (9) FM 21-30, *Military Symbols.*
- (10) FM 21-60, *Visual Signals.*
- (11) FM 21-305, *Manual for the Wheeled Vehicle Driver.*
- (12) FM 29-2, *Organizational Maintenance Operations.*

(13) FM 29-25, *Direct Exchange, Shop Supply, and Operational Readiness Float Procedures.*

(14) SB 700-20, *Army Adopted/Other Items of Materiel Selected for Authorization/List of Reportable Items.*

(15) SB 740-98-1, *Storage Serviceability Standard: Tracked Vehicles and Component Parts.*

(16) TB 9-2300-402-10, *Air Pollution Control Procedures for Military Vehicles, Construction Equipment, and Materials Handling Equipment.*

(17) TB 9-2320-218-10-1, *Safe Operations of Truck, Utility: 1/4-ton, 4x4, M151 Series.*

(18) TB 43-0142, *Safety Inspection and Testing of Lifting Devices.*

(19) TB 43-180, *Calibration Requirements for the Maintenance of Army Materiel.*

(20) TB 600-1, *Procedures for Licensing Operators of Equipment Managed by the U.S. Army Mobility Equipment Command.*

(21) TB 742-93-1, *Inspection and Test of Air and Other Gas Compressors.*

(22) TB 750-231, *Overhaul Evaluation Policy for Towed and Self-Propelled Artillery Items, Mortars, and Recoilless Rifles.*

(23) TB 750-651, *Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems.*

(24) TC 38-1, *Property Accounting and Army Equipment Status Reporting in Divisions; Functional User Procedures and Codes.*

(25) TC 38-2-1, *Class IX (Repair Parts) Supply System, Supply Operating Procedures, Using Unit Procedures.*

(26) TC 21-5-7, *Training Management in Battalions*

APPENDIX J

REFERENCES

- Abbreviations, AR 310-50
- Absence Without Leave, AR 630-10
- Accidents
- Motor Vehicle, Prevention, AR 385-55
- Reports (for firing), AR 75-1
- Air Attack, Small-Arms Defense, TC 23-44
- Airmobile Operations, FM 57-35
- Ammunition
- General, TM 9-1300-200
- Artillery, TM 43-0001-28
- Organizational
- Maintenance, TM 9-1300-251-20
- Transportation and
- Storage, TM 9-1300-206
- Awards and Decorations, AR 672-5-1
- Basic Ammunition Loads, FM 101-10-series
- Camouflage, FM 5-20
- Cannon Battalion Operations, FM 6-21
- Censorship, AR 380-200
- Charge Sheet, Manual for Courts-martial 1969
- Classified Documents (security), AR 380-5
- Cleaning and Lubrication of Vehicles/Equipment, Appropriate LO
- Combat Training, Individual Soldier, FM 21-75
- Communications Doctrine, FM 24-1
- Complaints, AR 20-1
- Correspondence Courses, DA Pam 351-20; AR 351-20
- Correspondence and Messages, AR 340-15
- Council Book
- (nonappropriated funds), AR 230-series
- Defense of the Battery, TC 6-20-9
- Dictionary of US Army Terms, AR 310-25
- Direct Fire Trainer
- (laser), TM 9-6920-357-10-2
- Driver Examination, AR 600-55
- Driver Manuals
- Tracked Vehicles, TM 21-306
- Wheeled Vehicles, FM 21-305
- Driver Selection and Training, AR 600-55; TM 21-300 (wheeled) and TM 21-301 (tracked)
- Duty Roster, AR 220-45
- Employment of Chemical Agents, FM 3-10
- Enemy Tactics,
- Organization, Equipment, FM 30-40; TC 6-4-1, TC 6-4-2
- Engineer Field Data, FM 5-34
- Enlisted Personnel
- Management, AR 600-200
- Equipment Maintenance, AR 750-1
- Field Artillery
- Communications, FM 6-10; TC 6-10-1
- Field Artillery Gunnery
- (Cannon), FM 6-40; FM 6-40-5
- Field Artillery Survey, FM 6-2; TC 6-2-1
- Field Artillery Trainer,
- M31 (14.5-mm), TM 9-6920-361-13 & P
- Field Fortifications, FM 5-15
- Fighting Position, Preparation, FM 7-7
- Film Index, Army Motion Pictures, DA Pam 108-1
- Fire Support, FM 6-20
- Fording, Deep Water, Vehicle TM; TM 9-238
- Graphic Training Aids
- Index, DA Pam 108-1
- Index to Administrative Publications, DA Pam 310-1

Blank Forms, DA Pam 310-2
Modification Work
Orders, DA Pam 310-7
Publications (FM, TC, ARTEP
FT, TOE, etc.), DA Pam 310-3
Publications (TM, TB, SM,
SB, LO), DA Pam 310-4

Leave Policy, AR 630-5

Legal Assistance, AR 608-50

Maintenance Management, TM 38-750;
FM 29-2;
DA Pam 750-1;
DA Pam 750-18

Map Reading, FM 21-26

Military Leadership, FM 22-100; FM 22-101

Military Symbols, FM 21-30

Motor Movements, FM 55-30; FM 55-31

Movement Reference Data, FM 55-15

NBC Defense, FM 21-40

Night Operations, FM 31-36

Nuclear Operations, FM 100-50

Officer Candidate School, AR 351-5

Operations, Army, FM 100-5

Organization of the Army, AR 10-series

Pay, AR 37-series

Personal Affairs, DA Pam 608-2

Personnel Authorizations,
Field Artillery, TOE 6-series

Preventive Maintenance, DA Pam 750-1;
TM 38-750

Qualification, Small Arms, AR 622-10;
FM 23-series

Radio Techniques (field), FM 24-18

Rations, AR 30-46

Riverine Operations, FM 31-75

Safety Program, AR 385-10;
AR 385-55;
DA Pam 385-1

Safety Regulations (firing), AR 385-63

Salvage/Surplus
Property Disposal, AR 755-2

Schools, AR 351-1; AR 351-25,
DA Pam 351-4

Supply Management, AR 710-2

Training, AR 350-1, FM 21-6,
FM 6-40-5, TC 21-5-7,
appropriate ARTEPs and SMs

Troop Information and
Education, DA Pam 360-series

Uniform Regulations, AR 670-5

Wire Techniques (field), FM 24-20

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